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MID-AIR OBSERVATIONS.

By John M. Bacon, F.R.A.S.

On carefully comparing the notes made by my daughter and myself on the morning when the Leonid shower was expected to be in progress, a few points of scientific interest have been brought out which may be worth recording, although having but little bearing on astronomy. It may perhaps be claimed that their value should be all the greater from the fact that the circumstances of our position as aerial observers, compelled by a strange chance to remain aloft for many hours, enabled us to give mature and undivided attention to the few principal facts which I proceed to detail.

Our actual view of such Leonids as were visible was undoubtedly much enhanced by the exceptional advantage we enjoyed of riding at 4,000 feet above any ground surface, and, moreover, riding with the air currents. Sufficient proof of this lay in the fact that the stars from every quarter shone out of a black sky with a brilliance and definition u[illegible] in my experience, save on a former [illegible] I made an equally elevated night voyage. The [illegible] of the radiant at the time of our ascent [illegible] sixty degrees, the body of the Balloon could hide such meteors as shot upward, but, among those seen, one at least was remarkable for its long-lasting trail, while at another time a burst of three or four, darting in twisting courses towards Orion, presented a peculiar phenomenon such as I cannot recall, resembling a small discharge of tailed stars from a rocket head. The unusual and persistently blue colour of Sirius was very noteworthy. Though its hue constantly changed, it could never have been described as possessing any other colour than blue.

Still more remarkable however was the green-grey colour of the dawn. This shade was evanescent but for the while strikingly noticeable, and corresponded with such dawns as were much more pronounced and long-lasting at the period following the eruption of Krakatoa in 1883. It becomes a question whether, paucity of visible meteors notwithstanding, there may not have been some unusual proportion of cosmic debris intercepted by the upper strata of the atmosphere as the earth crossed the track of the main Leonid stream.

Though the official time of sunrise on this morning was not till 7.21, it was two or three minutes before six when with us the dawn began to break, and this with a rapidity which I have not seen surpassed even in India. To explain this latter phenomenon I would suggest a double cause. First, that low-lying matter and moisture in suspension, capable of reflecting and diffusing light (and thus of anticipating dawn), had in great measure been surmounted; and, secondly, that as soon as appreciable light appeared its intensity was redoubled by reflection off the brilliantly glistening snow-surface below us. The cloud-veil here spoken of had been first entered at an altitude of 1,500 feet, and proved to be some 1,600 feet in thickness, and its thermal conditions were sufficiently remarkable.

Owing to the rapidity of our ascent, the temperature of the lower levels was not accurately taken, but though when we left the ground the night was one of exceptional mildness for November, entering the cloud layer struck us like passing into a warm greenhouse atmosphere, and its temperature certainly cannot have been less than 50 degrees. The upper fringe of the same cloud, however, tested accurately by a sling thermometer, showed a temperature of 38 degrees, while at a full thousand feet above in the clear open sky the same thermometer showed a reading 4 degrees higher. The Balloon gathered an extraordinary weight of condensed moisture necessitating the discharge of many bags of ballast, and all objects about us became rapidly and densely dewed; yet, at the upper surface where billows of mist, mountains high, were surging and vanishing into space, evaporations must have been going forward very briskly, the super-incumbent air being doubtless comparatively dry. It was just at the wasting upper fringe of the cloud that the sensation (unusual in a free balloon) of constant draughts was experienced, and this experience was repeated whensoever we dropped or rose into this particular region.

For the first hour the balloon constantly rose and fell with a strongly marked pendulous motion, owing to its many struggles with the moist cloud-wreaths and the continual discharge of sand; but, oscillations once over, its perfect poise was remarkable and unexampled in my own experience. The region in which is the [illegible] floated was probably shielded from ascending currents by the cloud-floor, and in the hour before sunrise the upper levels had doubtless subsided into an exceedingly quiescent and homogeneous state.

The cloud-floor itself, or rather its upper face, was worthy of the close attention which we were ready to give it through many long hours. Speaking generally it seems to have passed through three distinct stages. First and earliest, it presented a fluffy cotton-wool appearance, or perhaps could be better described—at least when viewed from a thousand feet or more above it—as wearing the appearance of recently fallen snow, lying deep but light and feathery.

Later on this seeming snowfield, interminable in extent, appeared of harder surface and more compacted like even snow when it has been subjected to bright winter sun for several days. Then in the end—as though to complete the analogy—these snow plains com-

1 p.m.—Cloud-floor as though thawing into hollows.

menced breaking up infinitely slowly, into black pits and hollows through which the actual earth, though several thousand feet below, began to show itself.

The trivial incident of our having suddenly found a big blue fly buzzing noisily about us, when hanging at a height of 8,000 feet, would have passed without serious notice but for certain correspondence which has since arisen. Mr F. T. Wethered, of the Alpine Club, writes to say that he has seen a butterfly scudding across the summit of the Grandes Jorasses at a height of 13,799 feet, and sees no reason why the fly should not have been on the wing and not taken up in the car as we had supposed. M. C. Flammarion tells of white butterflies fluttering round his balloon at 3,280 feet, though in the same voyage he remarks on the silence of bird and insect life at sunrise. My own experience has always been that winged creatures of every kind have been left behind long before the first thousand feet were reached. The height at which the swift is flying is surmounted with the first leap into space, and even when sailing at the lowest levels compatible with safety the skylark is neither seen or heard; very possibly, however, all creatures of the air take alarm at a balloon and naturally give it a wide birth.

Sounds claimed our closest attention throughout our voyage, inasmuch as we were constantly straining our ears to determine whether we were over land or sea. The deep cloud-barrier below us certainly appeared conducive rather than inimical to the penetration of sound from earth. At almost our highest elevation the bark of a dog was caught, while the shrill challenge of many cocks reached nearly as high. The bellow of cattle was heard at upwards of 6,000 feet, the ringing of horses' hoofs on a hard road at a thousand feet lower, and at 4,000 feet the unmistakable splashing of ducks on water. The strangest case of great penetration however was afforded by the splash of waves on shore. I would submit that our ears were highly strung and abnormally sensitive to this sound, as being that which we most dreaded to hear.

One other sound of an uncanny nature there was that began to haunt us as we reached the loftier regions. Amid the dead silence we heard, fitfully, stealthy footsteps as of someone walking softly outside the car.

When presently its cause was detected it proved to be a sound of ill omen. It was the stretching of the ropes under the hot sun, and the silk giving out as the gas continued to expand and send us mounting yet higher.

PLANTS AND THEIR FOOD.

By H. H. W. Pearson, B.A. (Cantab.).

As we observe the young wheat plants just appearing above the ground, and in a few months' time see the same plants, full-grown and almost ripe for harvest, we cannot but wonder what has been the nature of their food and whence they have obtained it. In the case of animals, at least of the higher animals, ordinary observation is sufficient to give us a good deal of information respecting the nature and sources of the food upon which they live. But no amount of observation will enable us to see anything of the nature of food entering the wheat plants. We know that they have roots in the ground, and can imagine that these take something from the soil which the plants use as food: this, however, teaches us nothing, and we soon realise that we must adopt some other method than that of out-of-door observation before we can hope to obtain the information which we seek.

It is more than 2000 years since philosophers began to speculate about the food of plants and what we may term their "digestive" processes, but it is only during the latter half of this century that really clear and definite notions concerning the food supplies of the vegetable world have been generally accepted by scientific men.

Aristotle could find in plants nothing which might be supposed to digest food materials in the same manner as the stomach of an animal; and he saw no trace of any excrement or useless matter being cast off. He therefore believed that no process corresponding to digestion took place in plants. In order that this might be possible he supposed that the food was not only obtained from the earth, but was so prepared in and by the soil that it could be taken up by the roots and at once applied to the purposes of growth without undergoing any further change. In other words the soil not only supplied the food materials but also digested them and yielded the products up to the roots in such a condition that they could be at once added to the substance of the plant. Strange as this idea appears to us, it did not finally die out until the XVIIIth century. Passing over the writings of several philosophers who were influenced in a greater or less degree by these ideas of Aristotle, we will notice the views of Van Helmont,* a Dutch physician of the

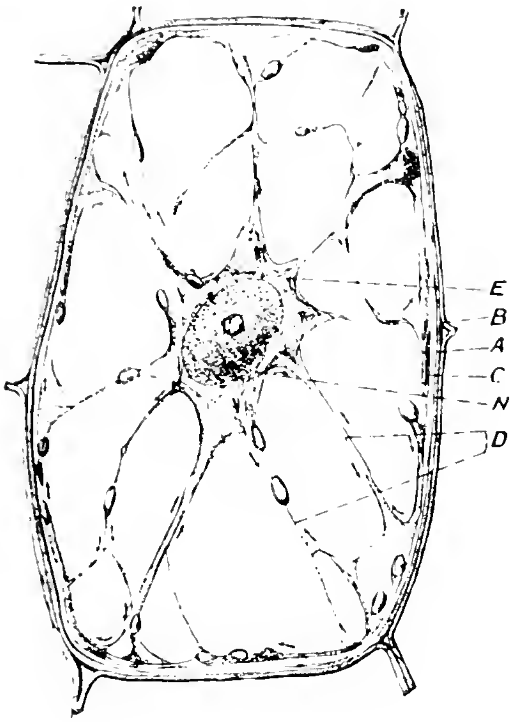


Fig. 1. (After Haustein.)—A living plant cell, very highly magnified. a.—The cellulose wall. b.—The wall of a neighbouring cell, which is not represented. c.—Inner wall of protoplasm (Primordial Utricle). d.—Strands of protoplasm connecting the Primordial Utricle with the central mass of protoplasm (e), in which the nucleus (n) is embedded.—From the figure in Vine's "Physiology of Plants."

XVIth century. He believed water to be the principal constituent of matter, and therefore of the body of the plant. Hence he considered that the food of plants consisted solely of pure water. This idea is nearly as far from the truth as that of Aristotle, but it is historically of great importance because it was supported by an experiment—as far as is known, the first botanical experiment ever performed. He placed in a pot 200 lbs. of dried earth, and in it he planted a willow branch which weighed 5 lbs. He kept the whole covered up and daily watered the earth with rain-water. After 5 years' growth the willow was taken up and again weighed and was found to have gained 164 lbs.; the earth in the pot was dried and weighed and had only lost 2 oz. Knowledge was not yet sufficiently advanced to enable Van Helmont to interpret these striking results correctly, and he came to the erroneous conclusion that the increased weight of the plant was due to the water which had been supplied to the roots. He therefore looked upon this experiment as supporting the theory which he had advanced, viz., that plants required no food but water. But although his conclusions were wrong, yet to him is due the honour of having been the first to adopt the experimental method of enquiry in investigating problems connected with plant life. A hundred years later a very important advance was made by Stephen Hales.† This distinguished English physicist was the first to prove that part at least of the food materials of plants is derived from the atmosphere. The vast importance of this discovery will be realised when we consider the assimilation of the Carbon dioxide (Carbonic acid gas) of the atmosphere by the leaves of green plants. Soon after the death of Hales it was shown that the Carbon of the plant is derived from Carbon dioxide of the air, and that at the same time the water of the soil containing nitrates and other mineral matters in solution is taken in by the roots and utilised as food material. The true interpretation of Van Helmont's experiment was that the increase in weight of the willow branch during the 5 years' growth was in a great measure due to Carbon which it had taken from the air.

By these discoveries a firm foundation for further investigation was laid. Although the progress made since the time of Hales has been far from uniform, it has been great, especially during the last 40 years, as we shall see in our further consideration of the subject. There is nevertheless a wide scope for further enquiry, and much remains yet to be discovered before all the problems connected with plants and their food can be satisfactorily solved.

A leaf-bearing plant may be looked upon as a republic whose units are called "cells." A large proportion of the cells of a living plant are dead, although they have by no means ceased to be of use to the plant; such are the hard fibres of which the wood of trees is largely composed, and which give to the trunk the rigidity which enables it to sustain the heavy weight of the branches and foliage. It is however with the living cells that we are chiefly concerned, in considering plants in relation to their food. We may regard a living cell as a very minute bag or sac bounded by a double wall. The size of the cell varies in different plants and in different parts of the same plant. Some idea of the average size of such cells may be conveyed by the statement that between 6000 and 12,000, spread out in a single layer would cover 1 square inch of surface. The outer wall of the cell (the cell-wall proper) is composed of an elastic‡ substance called "cellulose," which in its chemical properties resembles starch. A cellulose wall permits the passage of liquids through it, and must therefore be minutely perforated, though the perforations are so small as to be quite invisible under the highest powers of the microscope. The inner wall, sometimes called the "Primordial Utricle," closely lines the outer and is composed of a viscid substance called protoplasm, strands of which pass from points in the wall to the interior of the cell, and there unite forming a mass in which is embedded an oval body, the nucleus. The nucleus is also composed of protoplasm, but it possesses many remarkable properties which mark it out as a distinct body. Protoplasm consists of a mixture of substances called proteids, which are composed of Carbon, Hydrogen, Nitrogen, Oxygen, and one or two other elements. Its most remarkable character is that it possesses properties which lead us to speak of it as a living substance. Some of these properties will come under our notice at a later stage. As much of the cell as is not occupied by protoplasm is filled by a

* Born in Brussels, 1577.

† Born in Kent, 1677. Entered Christ's College, Cambridge, 1696. Fellow of the Royal Society.

‡ An "elastic" substance possesses the property of returning to its original shape after being stretched.

liquid known as "cell-sap," which is water holding in solution various materials which have been taken up from without by the roots and leaves. These materials are thus brought in contact with the protoplasm which causes them to undergo changes in composition that prepare them to be added to the substance of the plant. Thus it is in the protoplasm of the living cells of the plant that those "digestive" processes are carried on which Aristotle believed to occur in the soil. We see then that the living cells are microscopic laboratories in which the digestion of the food of the plant is carried on. And now that we know something of the nature of the laboratories to which the food materials have to be conveyed we can the more easily enquire into the nature and sources of the food supply.

As we cannot directly observe substances entering or leaving a plant, we must adopt other methods of investigation before we can learn much about the nature of its food. If we can ascertain of what substances a plant is composed, we shall at least know that by some means or other it has received these substances from outside. For example, when a cigar burns there remains an incombustible grey ash. Chemical analysis of this ash shows that it is composed of various substances, one of which is Magnesium. We know then that Magnesium was present in the cigar. If we were acquainted with the method by which the cigar was manufactured we might go back a step further and conclude that Magnesium was contained in the tobacco leaf from which the cigar was made, and therefore in the food of the tobacco plant. This is an illustration of the actual method employed when we wish to find out what are the substances which a plant acquires from the outside world. The whole of a well-grown plant is thoroughly dried at a high temperature, which is, however, not high enough to burn it. After being carefully weighed, the dried plant is burned in such a manner that not only the ash, but also the gases given off during the combustion, are collected. These are then weighed and analysed. The gases, which weigh considerably more than the ash, are found to be Carbon dioxide (CO_2), water vapour (H_2O), and Nitrogen. We should then conclude, on chemical grounds, that our plant contained Carbon, Hydrogen, and Nitrogen. The ash may contain a great number of elements, many of which are found in only a few plants; of these the following are almost always present—Calcium (a constituent of chalk), Magnesium (found in many Limestones,) Iron, Potassium, Sulphur, Phosphorus, Chlorine, Silicon, and Sodium, all of which are found in the soil. At the same time we should learn that our plant contained Oxygen. (It would take us too far to consider the reasons for this conclusion.)

It will be interesting to place side by side the results of such an analysis of Green Peas and Clover Hay: §

	Green Peas.	Clover Hay.
Carbon	46.5 per cent.	47.4 per cent
Hydrogen	6.2 " "	5.0 " "
Oxygen	40.0 " "	37.8 " "
Nitrogen	4.2 " "	2.1 " "
Ash*	3.1 " "	7.7 " "
	100.0	100.0

We cannot discuss here all the information that is contained in these figures. We notice, however, that the proportions of each constituent differ in the two cases, and this is true in all cases, even for similar parts of two plants of the same kind growing side by side in the same soil. And further, we see that in each case the Carbon weighs more than any other constituent. This is always the case in herbs and in the soft parts of woody plants.

§ Vine's "Physiology of Plants."

* All the mineral constituents are here included.

This method of analysis shows us what are the elements which a plant takes in from without. But we learn from it nothing concerning the forms in which these elements must be combined before they can be received by the plant. And further, it gives no information as to whether any of the elements in the substance of the plant may be more necessary for the general welfare of the body than any others; in other words, we cannot by mere analysis find out which are the necessary elements of the food as distinguished from those which can be dispensed with without injury to the life of the plant.

To attack such problems as these we must have recourse to other more direct methods of investigation. The most important of these is the method known as "water-culture." Plants are grown, sometimes for considerable periods, with their roots immersed in water in which various mineral salts are dissolved. "Sand-culture" is merely a modification of "water-culture"; in this the roots are in pure sterilised sand, to which such solutions as are used in water-cultures are added. From a great number of experiments of this kind it is possible to find the composition of a solution in which a plant will grow, for a time at least, as well as if its roots were in the soil under natural conditions. Such a solution, in which most green plants are able to find all the necessary elements of their food, has the following composition:—

Distilled Water	1,000—1,500 grammes.
Potassium Nitrate (Saltpetre)	1.0 "
Magnesium Sulphate (Epsom Salt)	0.5 "
Calcium Sulphate	0.5 "
Calcium Phosphate or Potassium Phosphate	0.5 "
A soluble Salt of Iron	A trace.

This solution contains all the elements which the roots of a green plant must find in the soil in order that its growth may be healthy. Other mineral elements found in plants are not as a rule essential constituents of the food. The proportions in which these substances are presented to the roots may vary without affecting the growth of the plant, for the roots have the power of regulating the quantities of each substance absorbed, so that none enters in excess. An important point to be noticed in the composition of this nutrient solution is that Carbon is not present in it in any form whatever. A green plant is able to obtain all its Carbon from the atmosphere, though, as we shall see later, it is quite possible that in Nature some of it is absorbed by the roots.

EXPLOSIONS IN COAL MINES.

By John Mills.

A most important example of an industrial result depending upon pure induction from abstract science is afforded by the Miner's Safety Lamp. The processes which, in the course of ages, have resulted in the production of coal—the preserved matter of primeval forests—the remains of a vegetable world, have also yielded an abundance of inflammable gas. This gas, known to miners as "fire damp" and to chemists as carburetted hydrogen, accumulates in the cavities and fissures of the coal itself, and of the adjacent strata; it is identical in composition with marsh gas, which causes the phenomenon known as "will-o'-the-wisp."

Fire damp, the scourge of the miner, more dreadful in its effects than those of the lightning and the earthquake, long defied investigation even as a scientific phenomenon. An element of destruction, apparently uncontrollable by human power, had to be grappled with and subjugated so completely as to be put under the management of the most uneducated miner. The gas in many mines is constantly issuing from the coal as it is worked, and sometimes emerges under great pressure when the cavity containing it is punctured by a pick or other means, the term "blower" being applied to such an escape of gas. When mingled with air, this gas forms a mixture which explodes violently in contact with a naked light.

By a pure inductive method Sir Humphry Davy traced its history, step by step, until he fully made out all its characters. He discovered that fire damp in reality requires a very high heat for ignition, the temperature of red-hot iron or charcoal being insufficient to inflame it. The gas was found not to explode in narrow tubes, as these cool it below the point of ignition, and a network of iron or copper wire is practically equivalent to a series of sectional tubes. A lamp surrounded by wire gauze was therefore used, and this allowed a light to be carried into the mine with safety. The destructive gnome of the mine was thus imprisoned within a cage of mere wire gauze, and, vainly struggling to escape, heated to redness the bars of its prison, thus affording warning of the presence of the gas in dangerous quantity. Science, to its glory, by this simple means greatly minimised those scenes of death and heart-sickening misery which haunted the miner in his most peaceful hours, and has rendered comparatively safe an occupation formerly one of dread and real danger.

"Black damp," the deleterious constituent of which is carbonic acid gas, is also evolved in coal mines, and though incombustible and inexplosive, it is fatal to life if allowed to accumulate to any considerable degree. Elaborate systems of ventilation are therefore in use to carry off these gases so as to prevent undue accumulation. Pure air is forced, pumped, or sucked down one shaft, and vitiated air let out at another, both shafts communicating with the surface, and the current thus set up sweeps out the mine, so to speak, but the "fire damp," being lighter than air, is liable to accumulate in inequalities of the roof and has sometimes to be dislodged by special appliances.

The main cause of death in explosions, however, is not the explosion itself, but the "after damp" generated by it. Dr. Haldane, who visited Tylorstown Colliery on the day after the terrible explosion there on January 27, 1896, resulting in the deaths of 57 out of 90 men in the pit, has shown that an examination of the bodies revealed the astonishing and unexpected fact that 52 out of the 57 deaths, that is, no less than 91 per cent., had been caused by "after damp," the remaining five having been killed instantaneously by violence. Of the men killed by "after damp," a post-mortem examination showed that in nearly every case the signs of carbon monoxide poisoning were present.

The safety lamp, in its present improved form, if carefully used, affords adequate protection, but it has been found when the lamps are left in the miner's possession and custody after he quits the mine, they are sometimes damaged by careless handling, and taken back into the mine in a defective and dangerous condition, with appalling possibilities. By the Coal Mines Act of 1896 legislation provided for the safe custody of all lamps used in mines, the removal of any lamp from the mine being forbidden.

But there are other sou[illegible] in mine[illegible]. The primitive wedge, used from time immemorial for detaching coal from the mass form[illegible] seam, has been superseded by the disruptive energy of explosives [illegible] the so-called "shot" in blasting operations. A shot improperly fired is called "a blown out shot," and the initial cause of the explosion is the jet of flame projected by the blown out shot. When the "tamming," or "tamping," used for confining the explosive within the boring prepared for it is not sufficiently rammed in to secure the complete internal combustion of the explosive, "a blown out shot" may be produced, and the effect is to cause a jet of flame to issue with great force from the orifice of the boring at the moment of the shot, so that if "fire damp" be present in quantity an explosion occurs and may extend throughout the mine.

As some explosives are unduly dangerous, the Secretary of State, in accordance with the provisions of the Act of 1886, has had drawn up a "Permitted List," that is, explosives which owners of mines are required to choose from as safest and best. At Woolwich Arsenal there is a station provided with apparatus designed to test the effect of firing explosives in presence of inflammable mixtures of atmospheric air with either coal-gas or coal-dust. The charge of explosive is fired from a steel cannon with a uniform stemming of dry clay, these conditions representing very closely those of "a blown out shot." No explosive was considered to have satisfied the test if it caused more than two failures in forty shots—a failure being either an ignition of the gaseous mixture or an incomplete explosion leaving a residue of explosive unconsumed.

Another medium of disaster is coal dust, harmless enough till the work of destruction has once been started; existing everywhere in the labyrinthine passages, as dust suspended in the air, it serves as a ready distributor of flame and, therefore, explosion in all directions from the local point of origin. It may be seen in miniature when dry and dusty coal is thrown on a fire from a coal scuttle, the finer coal dust is immediately inflamed by contact with the glowing coals in the grate, and passes up the chimney in the form of a feeble explosion.

Faraday, on scientific and experimental grounds, suggested that coal dust contributed largely to the devastating effect of an explosion. A zone of safety is generally obtainable by saturating the dust in the immediate neighbourhood of a contemplated shot. It is estimated that the total number of shots fired in the United Kingdom amounts to at least 20,000,000 annually.

Between 1851 and 1889, inclusive, there were 2,060 colliery explosions, and the number of lives lost was 8,859; during that period some 900,000,000 shots must have been fired, giving a percentage of explosions to shots of 0.000229, and of lives lost to shots of 0.000985. In the decade ending 1882, the ratio of mortality by explosions of fire damp was .65 per 1,000 persons, in the next decade .32. In 1893 it was .29, and in 1894 .56. Lower still in 1895—namely, .10, and up at .31 in 1896. In 1897, the first year in [illegible] the new Act was in force, the ratio fell to .03 and in 1898 it had risen a little—namely, to .05. The accompanying table shows the number of persons employed underground in coal mines and the output for the years given:

Year.	Number of Persons Employed.	Output in Tons.
1896 ...	557,[illegible] ...	208,503,868
1897 ...	558,[illegible] ...	215,115,025
1898 ...	567,1[illegible]1	215,[illegible]

It is gratifying to learn that the efforts put forth by the Legislature in recent years for the effectual prevention of explosions in coal mines are being attended by results which show that mortality is not near so rampant as it was formerly. In the last two years, that is, in the two years which, at the end of 1888, had elapsed since the Act came into force there had been no great and devastating explosion. Still, even now, our knowledge of the causes, circumstances, and effects of explosions in mines, whether of fire damp, of coal dust, or of both, is still very far from complete—indeed, is in many respects of little more than a rudimentary character. But let us not under-estimate the labours of those who have captained us thus far in our conflict with the miner's deadly foe.

THE NATIVES OF AUSTRALIA AND THEIR ORIGIN.

By R. Lydekker.

If the visitor to the Natural History Museum at South Kensington direct his attention to a case in the upper Mammalian Gallery bearing the superscription "Comparison of Man and Apes: Craniometry," he will scarcely fail to be struck by the remarkable difference presented between the palates of three skulls placed side by side, and respectively labelled Mongolian, Australian, and Chimpanzee. In the first the teeth, which are of comparatively small size, form a regular unbroken horseshoe-like curve, as they likewise do in a European; while the bony palate of the skull is so short that its transverse diameter considerably exceeds the longitudinal. On the other hand, in the Australian skull the individual teeth themselves are larger, and instead of the whole series forming a regular horseshoe, the line of grinders on each side, together with the eye-tooth, or canine, forms a distinct angle with the incisor line in front. Moreover, the palate is longer and narrower than in the Mongolian skull; the length of its longitudinal diameter exceeding the transverse. Turning to the Chimpanzee skull, the observer will notice that the features indicated in that of the Australian are intensified; the palate itself being much longer than broad, while the teeth are proportionately very large, and those on each side are arranged in a straight line, curving slightly inwards, and forming a marked angle with the incisors in front, from which they are separated by a distinct gap.

Looking at the three palates, the impartial observer can scarcely fail to see that although the Australian is nearer to the Mongolian than it is to the Chimpanzee, yet it forms a very marked step in the direction of the latter, and that if we had but one more link, the gap between the Mongolian and Simian palates would be practically bridged. Indeed although, judging from the skull alone, the European should have no hesitation in claiming the Australian as a fellow man, yet to say that he is a "brother" would be stretching that somewhat elastic term very hard indeed—an extremely distant cousin would more adequately express the relationship!

Had we only Australians on the one hand and Europeans and Mongolians on the other to deal with, it appears highly probable that we should be perfectly justified in regarding the former as a distinct species of mankind. For not only is there the above-mentioned striking difference in the structure of the palate, but (not to mention other points of distinction) the spinal column of the Australian lacks the full development of the exquisite curves of that of the European, and thus approximates to the Chimpanzee and Gorilla. As a matter of fact, however, the frizzly-haired Melanesians of Oceania, as well as the true Negroes of Africa, stand in some degree intermediate between the Australian and the European in respect to the structure of the skeleton, and thus forbid us regarding the former as a species apart.

One of the greatest puzzles in the science of anthropology is indeed to understand the relationship of the Australians to other races of mankind. In their skeletal structure they undoubtedly come nearest to the Melanesians and the African Negroes, although presenting a still more primitive type. Their black complexion, thick and pouting lips, projecting jaws, large teeth, and long skulls are indeed essentially Negro characters. Their eyes, too, are deeply set in the skull, and their legs show little or no calf. In the prominent ridges over the eyes, they frequently exhibit (see Plate) a resemblance to the Melanesian rather than to the African Negro type, in which these brow-ridges are undeveloped. Australians likewise resemble Negroes in that the colour of the skin of the infants is light yellow or brown instead of black; the adult sable tint not being acquired till between eighteen months and two years of age.

But (and this is a very large "but" indeed) here the resemblance ceases; for all Australians are broadly distinguished from Negroes and Melanesians—even their near neighbours the Tasmanians—by the character of their hair, which, in place of being "woolly," or frizzly as it may be better termed, is at most bushy, curly, or wavy; being generally coarse in texture and black in colour. The beard and moustache are likewise well developed; and in fact, as the illustrations show, Australians cannot be distinguished by their hair from the wild tribes of India, who are generally regarded as having no near relationship with Negroes, and who display no markedly low type in the form of the palate.

Before attempting to consider the meaning of this marked difference between Australians on the one side and Negroes and Melanesians on the other, it may be well to devote a few lines to the essential distinction between frizzly and other types of hair. If sections be taken from the hair of a horse's tail or mane, and then be examined under a microscope or lens, it will be found that they are perfectly circular; and the entire hair being thus cylindrical, it naturally hangs straight down. The lank black hair of a Japanese, a Chinese, or an American Indian is of the same cylindrical type. On the other hand, the hair of an average European when seen in section presents an oval ellipse, and thus causes the waviness so frequently noticeable. When, however, the hair of a Negro or Melanesian is sectionised, it is found to present a flat ellipse; and it is owing to this peculiar structure that the hair of these peoples assumes its characteristic frizziness. Now it is very noticeable that in crossbred races, such as the Brazilian Capesos (Negro and Native half-breeds, who are mop-headed like the Papuans), this frizziness of the hair tends to persist; and a hybrid described as half Negro, a quarter Cheroki, and a quarter English, is stated to have retained the Negro "wool." Hence it has been suggested that frizzly hair represents the primitive human type of capillary adornment.

But if we examine the hair of a Chimpanzee, Gorilla, Orang-utan, or indeed any other Old World Ape or Monkey, it will be found to be of the straight type, and to show not the slightest tendency to frizziness. Clearly then, from the evolutionary point of view, the straight-haired type ought to be the original one; and we find the late Sir W. H. Flower saying that the frizzly type "of hair is probably a specialisation, for it seems very unlikely that it was the attribute of the common ancestors of the human race."

If this hypothesis be true, it would point to the conclusion that the Australians are a more primitive type than the Melanesians and Negroes; a view which receives strong support from the primitive characters presented by their skeletons. But it must be observed that Sir William Flower, in spite of the opinion expressed above, suggested that the Australians are a mixed race, derived from a crossing between frizzly-haired Melanesians and some low type of the Caucasian stock, such as the wild tribes of Southern India. It may be urged, however, from what has already been said in regard to its persistence among half-breeds, that the frizzly type of hair would be very unlikely to have so completely disappeared among the Australians; added to which is the circumstance that had such extensive crossing with the Caucasian stock taken place the Australians could scarcely have preserved such an extremely low type of skeletal structure—a type which, at least as regards the palate and the spinal column, appears lower than that of either Melanesians or Negroes.

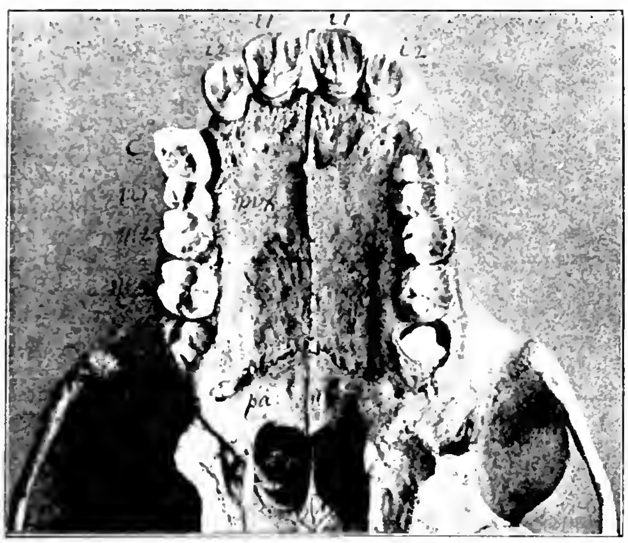


Fig. 1. Palate of skull of Chimpanzee.

That the Australian aborigines reached their present home from south-eastern Asia may be regarded as almost certain; and some have considered that the migration took place at a time when there was still a more or less complete land connection between Malaysia and Australia. Moreover certain South Australian tribes are considered to be closely related to the ancient inhabitants of Europe, as typified by the famous Neanderthal skull. Hence there is nothing improbable in the supposition that both of the Australians and the primitive Caucasian tribes of India are the descendants of a common stock, the Australians having retained the primitive character of their Neanderthal ancestors, while the Indian tribes have attained a higher grade of evolution. On this view the frizzly-haired Melanesian and African Negroes, as well as in all probability the round-headed Negritos of Luzon, in the Philippines, would be descendants from the primitive stock of which the Australians are less modified representatives. And in this connection it is important to mention that Dr. O. Finsch, who has travelled much in Australia, is of opinion that the Australian aborigines form a single and peculiar race, which differs more from either typical Melanesians or Papuans than do both the latter from African Negroes.

The general physical similarity of the natives from all parts of Australia is indeed a very striking peculiarity of the race, and serves to show that, whatever be their origin and their relationship, they have been, previous to the European colonization of their island continent, isolated for an immense period of time from the rest of the human race.

Their unity of type and isolation from other races is strongly emphasised by their language, which while uniform throughout the country, is at the same time quite distinct from that of any other people. It has indeed been attempted to connect the Australian tongue with that of the Dravidian races of Southern India, but this, according to recognised experts, is stated to have resulted in total failure.

There is, however, a very curious connection between the Australian aborigines and certain of the wild tribes of Southern India, namely that both possess the boomerang; a weapon unknown to any other members of the human race.* Of course there is the possibility that this very remarkable implement has been independently invented by the two people who use it, but there is a considerable degree of improbability in this idea. If, on the other hand, it be an inheritance of the Australians from Asiatic ancestors, it may be fairly argued that it is unlikely to have been evolved at the extremely remote epoch when the ancestral Australians started from their Asiatic home. And if this view be accepted, then we are compelled to revert to the idea of a later immigration from Asia, which brings us again to the question of the origin of the wavy hair of the Australians.

Apparently there is no possibility of giving a definite answer as to the origin of the boomerang; but there is one very curious point which may indicate the great antiquity of its introduction. As most of my readers are aware, the Australian aborigines possess a semi-domesticated dog—the Dingo; and there are strong reasons for regarding this animal as not pertaining to the indigenous fauna of the country. Its remains are, however, met with in association with those of a number of extinct animals, so that the date of its introduction was evidently very early. But if, as some suppose, man reached Australia at a time when it was much more closely connected with Malaysia than is at present the case, his advent might well have been contemporaneous with that of the Dingo. And here comes in the point referred to, namely, that (as I learn from an expert) the Dingo is very closely related to the Paria dogs of India. Now since these latter are domesticated breeds, the evidence, if it may be relied on, points to a very early immigration into Australia of aboriginal tribes accompanied by dogs from Asia. And if such early aborigines had domesticated a dog, they might surely be deemed capable of having invented the boomerang.

* The boomerang of India has not the return flight of the Australian weapon.

Like [illegible] tribes who have been brought into connection with Europeans, the Australian aborigines, especially in the districts longest colonised, have altered—and frequently for the worse—from their primitive condition; while they have also sadly diminished in number. Writing, under the pseudonym of "An Old Bushman," so long ago as 18[illegible], an observant settler in the vicinity of Melbourne made the following remarks.—"Of the many thousands who inhabited the colony before the arrival of the white man, not 2000 survive, and most of these are on the banks of the Murray. Although debased far below their own savage level since their intercourse with the white man, the few that are left still retain much of that free independent spirit and wild roving disposition which characterize all savages who have to get their living by the chase. For although they get their rations all the year round at the head station, they never care to live long in one place; but, following up the habits of their early life, make periodical excursions into the bush at different seasons, when the different game is in. Thus swans' eggs, kangaroo, ducks, eels, and crayfish, all furnish them with food and occupation at different seasons."

The procuring of a sufficient supply of food is indeed the great problem of the life of the aboriginal Australian; especially as his weapons, with the exception of the boomerang, are of an extremely poor description. Consequently these people, if we may judge from the accounts of those who have had the best opportunities of observing them, are some of the best, if not actually the best hunters and trackers in the world; indeed, Dr. Semon unhesitatingly assigns to them the highest position in this respect. Nothing that can be in any way regarded as edible seems to come amiss to an Australian, even such unsatisfactory morsels as grasshoppers, beetles, and fleas being consumed with relish. Probably the difficulty of obtaining a sufficient food supply from other sources was originally the reason that cannibalism came into vogue, but when once established it assumed a prominent place, Dr. Lumholtz telling us that human flesh is the greatest dietary luxury that these people in their primitive condition enjoy. In the proper sense of the term the Australian appears to have no religion at all; at any rate it has been authoritatively stated that he has never been observed either to pray, worship, or offer sacrifice, and that in his natural condition he has no sort of conception of a future state of existence. His extremely low grade of development is likewise strikingly exemplified by the treatment accorded to the female sex—a treatment perhaps only paralleled among the Fuegians. Such of my readers as wish to

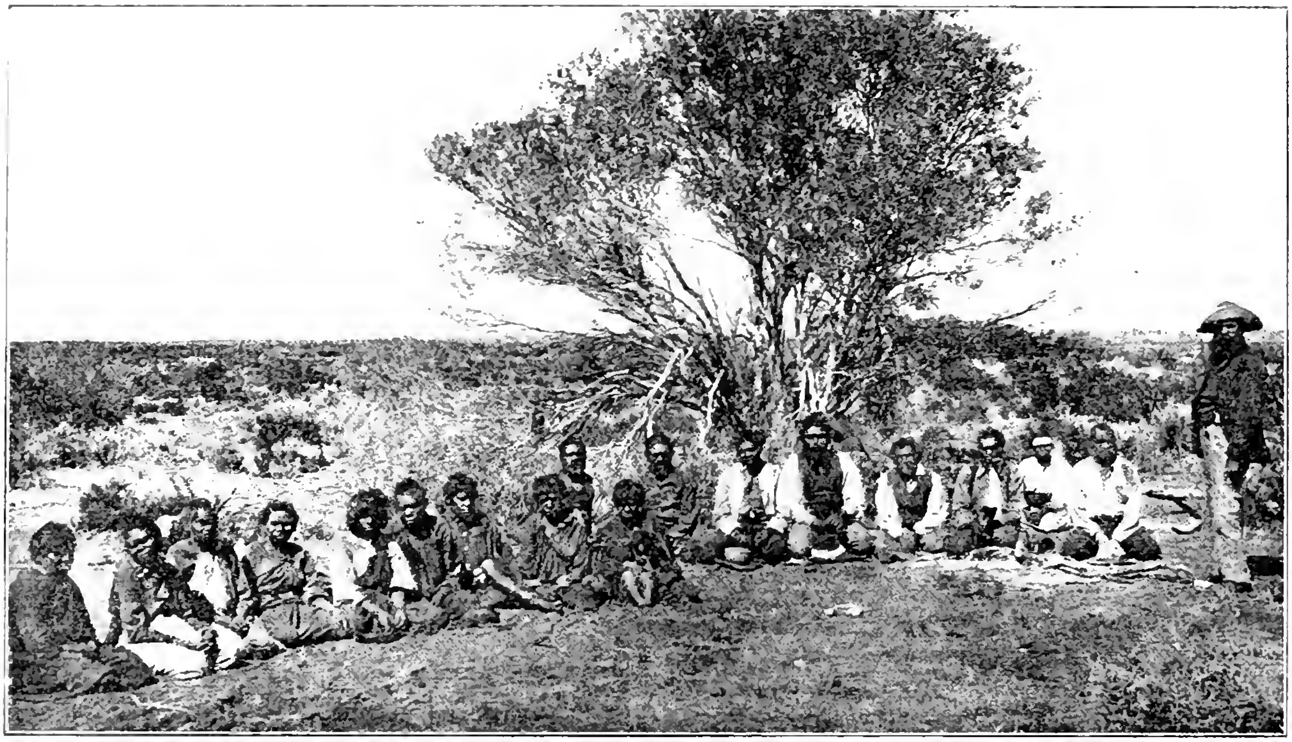


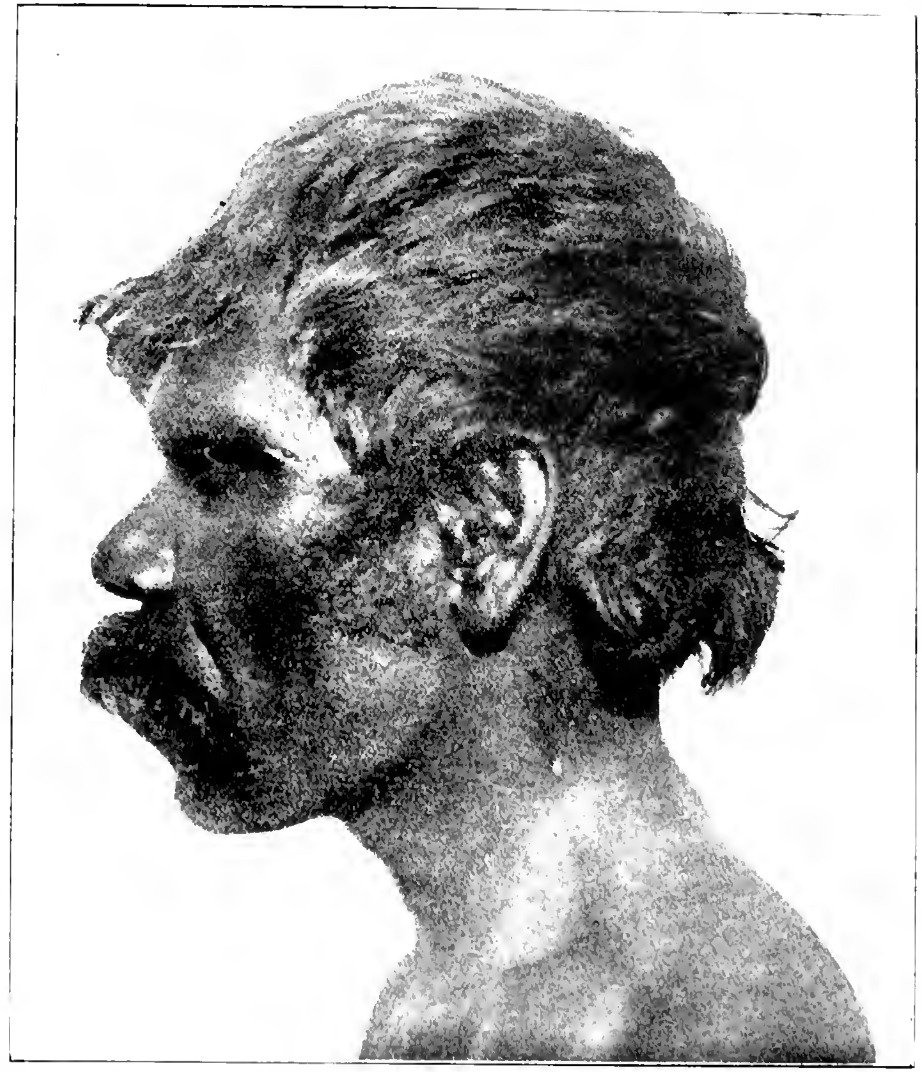
FIG. 2.—Group of West Australian Aborigines.

learn how brutal this treatment is, may refer to the works of Dr. Semon and Mr. Brough Smyth; but no good object would be gained by quoting the pitiful details in this place. Neither need detailed reference be made to the complicated system of class marriages which obtains among certain of the tribes. Although under a careful system of education in European schools the native children are capable of acquiring a certain amount of knowledge, displaying a decided capacity for drawing, there can be no doubt that the mental capacity of the Australian in his primitive condition stands at an extremely low level. No better exemplification of this can be cited than his arithmetical capacity—or rather incapacity. So low indeed does he stand in this respect, that none of the tribes have a word to express a number higher than three, while some content themselves with those for one and two. Mr. E. M. Carr is of opinion that no uninstructed Australian native can by any possibility count even as high as seven correctly. "If you lay seven pins on a table," he writes, "for a Black to

NATIVES OF WESTERN AUSTRALIA.

From Photographs by the Curator of the Perth Museum.

Full-face Portrait of a Woman, exhibiting the long wavy hair, broad nose and thick lips, characteristic of the race.



Profile View of a Man. Shows the deep notch at the junction of the nose with the forehead, which forms such a marked feature in Australians.

reckon, and then abstract two, he would not miss them. If one were removed, he would miss it, because his manner of counting by ones and twos amounts to the same as if he reckoned by odds and evens." It is difficult to imagine anything much lower than this.

Perhaps their one redeeming quality is their honesty and truthfulness; the "Old Bushman" stating that though they will ask for any article that may take their fancy, as if they had a right to it, yet that he never knew them to steal. All who have had much intercourse with them agree that they are naturally a merry and humorous people, with a great capacity for mimicry, taking off with facility any peculiar personal mannerism of those with whom they may be brought in contact, or imitating the movements of the kangaroo and the emu.

To work of all kinds they have a rooted objection, and the writer last mentioned gives it as his opinion that it would be impossible to make a slave of an Australian Black. Nevertheless, if I may judge from certain photographs lent me by Mr. B. Woodward, of the Perth Museum (to whom I am indebted for those illustrating this article), the aborigines remaining in the settled districts do now perform a certain amount of labour. They have also taken (as shown in the annexed illustration) to European clothing—of sorts. But, to quote once more from the "Old Bushman," the Australian ladies, who are by no means remarkable for personal beauty, at least from a European standpoint, "seem to care nothing for finery or ornaments, a dirty blanket, or opossum-rug wrapped loosely round them, and a short black pipe stuck in their hair completes their toilet." Not improbably my lady readers will consider this a more convincing proof of the low grade of the Australian aborigines than any other instance that could be mentioned!

Since writing the above, I have had an opportunity of carefully reading Dr. Semon's book "In the Australian Bush," and am pleased to find that he agrees with the views here expressed as to the racial distinctness of the Australian aborigines from their neighbours. But he goes a step further than I have ventured to advance, and suggests that the Australians are really near relations of the Veddas of Ceylon, and are therefore in reality a low branch of the primitive Caucasian stock, and have nothing to do with Negroes, to whom they are commonly affiliated.

ASTRONOMY WITHOUT A TELESCOPE.

I.—INTRODUCTORY.

By E. Walter Maunder, f.r.a.s.

Some years ago, when the Sioux Indians were beginning to get restless and to threaten trouble, it was thought expedient by the authorities at Washington to invite some of the discontented chiefs to an interview with their "Great White Father," the President, and, incidentally, to give them a demonstration of the vast resources which they would have to encounter if ever they took up arms against the Federal Government. So they came, and were shown some of the mighty machines which modern engineering has produced and in particular some hundred-ton guns. The monster weapons were duly manœuvred for the red men's benefit. They were loaded and fired, and the Indians were conducted to the ruin which had been the target that they might mark the terrible destruction which the missile had wrought. The Indians looked, but instead of being overwhelmed with astonishment and fear, as their guides had expected, betrayed only a slightly bored indifference. The United States official in charge of the demonstration repeated and emphasized his explanations when one of the chiefs, with just the faintest ghost of a satirical smile, which was the utmost manifestation of feeling his stoical sense of dignity allowed him, said, pointing to the unwieldy weapon, "You won't come after Indian with that."

It was true! The officials felt its force at once, and the Indians were treated to no more exhibitions of heavy artillery practice. It had been forgotten that the most powerful weapon is not necessarily the most effective for every purpose, and that for some classes of work the great size of an instrument may be a fatal disqualification.

A very similar mistake is sometimes made in regard to astronomy, and has no doubt interfered with the popularity of the science as a pursuit. It is too often assumed that nothing of real interest or utility can be achieved without the possession of telescopes of enormous power and of corresponding cost. The great observatories maintained in various European countries by the State, or founded in America by millionaires, like Lick or Yerkes, have been thought to command a monopoly of the astronomical advances of the future, since they only possess the telescopes of greatest light-gathering power and most perfect definition.

This view is far from correct. In the first place such an assumption entirely overlooks a consideration expressed as follows by Mr. W. H. Maw, f.r.a.s., in his recent most admirable Presidential Address to the British Astronomical Association, an address to which I would refer all who are likely to take up practical work in astronomy. Mr. Maw points out that

> "By the time a refractor of this kind has been erected and equipped, the outlay upon it will have become so large that it would be utter folly to use the instrument for work other than that for which its great power renders it specially fitted. The result of this is that our modern giant telescopes are, with few exceptions, employed, not in doing work which was formerly done by smaller instruments, but in doing work which formerly could not be done at all. Such, for instance, is the bulk of stellar spectroscopic work, including determinations of velocity in the line of sight, the measurement of close double stars, the spectroscopic examination of nebulæ, the discovery of new planetary satellites, and similar matters. We see, therefore, that the establishment of these powerful telescopes has been accompanied by the development of new fields of research, and that the work which was formerly done—and can still be well done—by instruments of moderate size has not been reduced." *

Nor is this all. Not only are the new giant telescopes necessarily devoted almost entirely to work which smaller instruments cannot touch, thus leaving to the latter the observations within their compass, but there are departments of work for which a great refractor is as wholly unsuited as a hundred-ton gun would be for fighting a Red Indian or shooting snipe. Great light-gathering power is not always the most important quality; for some researches broad grasp of field is far more essential, and here the giant telescopes are practically useless.

Prof. E. E. Barnard, in one of his lectures on Astronomical Photography, illustrated this point by showing a photograph of the great nebula in Andromeda, with all the marvellous detail of ring within ring which the photographs of Dr. Roberts and his followers in this field have made familiar to us. Then over this

* *Journal of the British Astronomical Association*, Vol. X., No. 1, p. 8.

he would place a mask, cutting down the field of view to the area which was the largest which the great 36-inch refractor of the Lick Observatory could command. It was seen at once that, however powerful the light-grasp of that telescope, it was quite beyond it to give any idea of the structure of so large a body as the Andromeda nebula, when considered as a whole.

But there are other objects in the heavens of far vaster area than the Andromeda nebula, and to deal with these in their full extent requires a wider field than any telescope can cover: they must be observed directly with the unassisted eye.

There are, then, definite branches of astronomy in which the telescope is not only unnecesary but, more than that, it is a hindrance. Apart, however, from this, it is well to remember that the science was pursued with great success for some thousands of years before ever the telescope was even conceived. The length of the year, the obliquity of the ecliptic, the fact and amount of precession, the chief lunar inequalities, the inclinations of the planetary orbits, and their relative dimensions were all determined by direct eye observation, and with a really remarkable approximation to the truth. Indeed, in our own day the same feat has been repeated, for, as readers of Knowledge will remember,* there is still living in Orissa the Hindu astronomer, Chandrasekhara, who, with home-made instruments and without optical assistance, has redetermined the elements of the chief members of the solar system with a most astonishing accuracy. Work of this kind may not indeed "increase the sum of human knowledge," for it is to repeat with very small and imperfect means what is being done with the most perfect appliances in the great public observatories of the world. But it is far from being waste time and effort on that account. As a training in keenness of perception and in habits of order and accuracy in observation it will be of the utmost service. It is not every man who climbs the ropes of the gymnasium who expects or wishes to become a sailor, and so to turn the skill he acquires to direct service in exactly the same line; but the strengthening of his muscles and the increase in agility are solid gains to him none the less.

Mr. Maw's words† on this subject also are well worth quoting, and I make no apology for introducing them:—

"What was done in the olden times can be done in the present day, and I wish to prominently direct the attention of beginners to the fact that by the employment of quite simple apparatus they may make observations which will bring home to them in a way which mere reading can never do, a knowledge of many astronomical phenomena which they will find to be, not only of immediate interest, but of great value to them in their further studies.

"What I wish to urge, therefore, is, that those commencing the study of astronomy should not be content with reading only, but should work in the open air, faithfully and systematically recording their observations, however elementary these may be. I lay great stress on this latter point because unrecorded observations have, as a rule, little educational value. The mere fact of describing in writing any observation, however simple, which has been made is of immense assistance in securing completeness and accuracy. Of course, the country offers greater facilities than towns do for this out-of-door work, but there are few towns where access cannot be had to some convenient site giving a fairly clear horizon and sufficiently free from traffic to allow of star maps being referred to without serious inconvenience. Naturally the beginner's first endeavour will be to identify the brightest stars and trace out approximately the outlines of the various constellations. Continuing this study he will gradually acquire a knowledge of the paths followed by the stars in their courses from rising to setting, and obtain a clear idea of the position of the apparent axis of this motion. As time goes on, he will further notice that the constellations he has identified set earlier and earlier each evening, and that other constellations previously unseen will come into view on the eastern horizon. Further, he will notice that the path followed by the moon in her course through the sky not only differs at different parts of a lunation, but varies for any given part of a lunation at different seasons of the year. As his knowledge of the sky progresses, he will be able to identify any bright planets which may be visible, and to observe their changes of position with regard to the adjacent stars, changes which he will do well to note in his sketch-book for future reference and consideration. Now, the beginner who has learned these elementary facts by actual observation of the sky, and has subsequently by the aid of his text-books mastered the reasons for what he has observed, will have made a very fair start in the study of astronomy, and he will, I venture to think, have acquired a far keener interest in the motions of the heavenly bodies than he would have possessed if he had confined his attention solely to books, or if his open-air observations had not been of a systematic character. He will also find that by the aid of some very simple home-made instruments, such as a cross-staff, a rude form of transit instrument, and other similar appliances, he will be able to make observations which serve to still more impress upon his mind the facts he has been learning. Of course, such observations must be crude and wanting in accuracy, but they will, nevertheless, be found to serve a very useful educational purpose."

It is therefore possible to become a real astronomical observer without a telescope and without any outlay except that necessary to procure a good star atlas. And although it may appear a useless labour thus to traverse for oneself the steps by which the early astronomers attained a knowledge of the universe, yet the value of the training involved will be immense, and the delight to be derived from personally watching in progress the majestic movement of the heavens, the sublimest machine in creation, will soon be felt to be enthralling.

But however great the interest that may be taken in work of the kind just described, the observer will be sure, ere long, to desire to do something which shall be of value for its own sake, as well as for its secondary effect as training. And, as has been already intimated, there are certain fields, by no means too fully cultivated, which are full of interest, and for which no giant telescopes are required; indeed, in these domains, the unaided eye is the ideal instrument.

First of all, there is the observation of Meteors. The past November has afforded a great deal of popular interest, of a sort, in the subject of meteors. Articles and letters in all the newspapers of the land excited general expectation to the utmost. Everyone was anxious to see a display of natural fireworks, exhibited without charge, and which would utterly outdo any efforts of human pyrotechny. It is perhaps no loss to science that the expectation was doomed to disappointment. But though everyone was eager to be a spectator at a magnificent display, there are very few indeed who have cared to become serious observers of meteors. Yet the work is of great interest and value, if systematically carried out; and the work of a single observer, Mr. W. F. Denning, has supplied us to-day with the most perplexing problem that still remains without solution of all astronomy: the problem of "stationary," or "long enduring radiants."

Next, comes the study of the Milky Way. Here again no telescope is required. A clear sky, keen sight, and great patience are the requisites. And this field is also one which scarcely any observer has taken up. When we have mentioned Heis, Boeddicker, Easton, and Wesley, we have almost exhausted the roll of explorers of the Galaxy. Yet night after night its mysterious convolutions are drawn out athwart the sky,

* See Knowledge for November, 1899, p. 257.

† *Journal of the British Astronomical Association*, Vol. X., No. 1, p. 12.

the ring which encloses our universe, the true Mitgard snake that encircles the entire world. Only to the most constant and patient scrutiny will it give up its secrets; yet how large a proportion of the mystery of our Cosmos is involved in an understanding of its structure who can tell?

Thirdly, there is the Zodiacal Light. We in these high northern latitudes are not well placed for watching it; but it can be seen from time to time, and a thorough use of the opportunities that do come will go far to compensate for our less favourable position. And it is worth mentioning, in this connexion, that the Gegenschein, the faint counterglow to the sun, more difficult and elusive than the Zodiacal Light proper, was independently discovered by an Englishman, and not a dweller in Southern England at that, by Mr. Backhouse of Sunderland.

In the Zodiacal Light, and the Gegenschein, we have again objects of the greatest interest and mystery, which are quite unfitted for telescopic examination, are truly naked-eye objects, and which to this day have never been sufficiently observed.

Fourthly, there are Auroræ. At the present period of the sunspot cycle there is no reason to expect any immediate recurrence of these beautiful phenomena. But careful training in the knowledge of the constellations and in the three branches of work just mentioned will be the best possible preparation for properly observing Auroræ when they set in again. And this is most important. After a great display it is very easy to collect a number of most vivid and picturesque descriptions, but really useful and scientific accounts are apt to be sadly wanting.

All these four branches of astronomy are essentially for the naked eye; in a fifth, that of variable stars, a great deal may be done without a telescope in the strict sense of the word, that is to say, a good opera-glass will suffice for a considerable number of objects. An opera-glass also greatly adds to the number of objects which are brought within the observer's range of vision. In the series of papers to which the present is intended to serve as introduction, it is my intention therefore not to limit myself entirely to work which can be done without any optical aid at all, but to include in "Astronomy without a Telescope" observations for which a good field-glass will suffice.

My programme, therefore, may be divided into four parts. First, lessons in the configuration of the constellations, so that the principal stars may be easily recognised. Second, simple observations with the naked eye for training in the habits of astronomical work. Third, observations with the naked eye of Meteors, the Galaxy, the Zodiacal Light and Auroræ. Lastly, observations with the help of an opera-glass; mostly of Variable Stars.

THE CONSTITUENTS OF THE SUN.

By A. Fowler, F.R.A.S.

Of all the heavenly bodies open to our enquiries, the Sun is the one which can be best submitted to the processes of spectrum analysis; in the first place because its light is so brilliant that instruments of great power can be utilised, and in the second place because it is near enough to admit of its component parts being separately observed. Through the use of spectroscopes of high dispersion, and the increased attention given to spectroscopic work during recent total eclipses, the data at our disposal for deductions as to the chemical constituents of the sun has of late been enormously extended, and it may serve a useful purpose to briefly summarise the present state of our knowledge on the subject.

Information relating to the solar light is arrived at by three different routes. First of all there is the Fraunhofer spectrum of dark lines, by which we may investigate the constituents of that part of the sun's atmosphere which produces discontinuous absorption; then there is the bright line spectrum of the chromosphere and prominences; and, finally, that of the corona. (Fig. 1.)

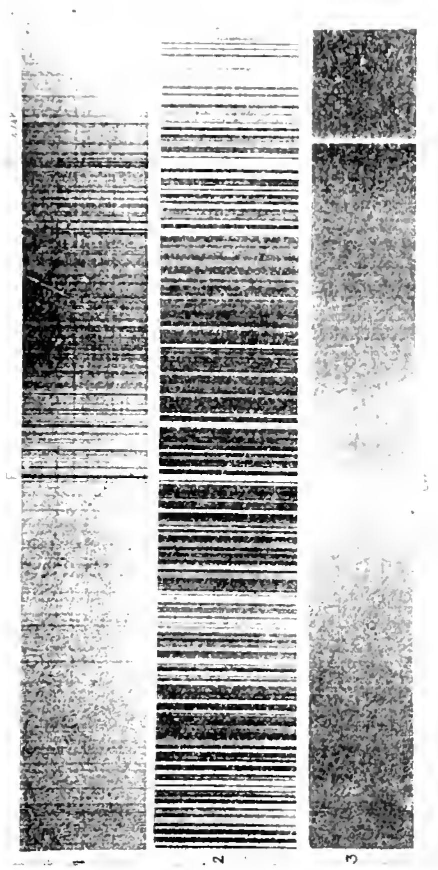


Fig. 1.—The three sources of information as to the composition of the sun. (1) Fraunhofer spectrum of dark lines. (2) Bright line spectrum of the chromosphere. (3) Bright line spectrum of the inner corona. (The F line in this spectrum belongs to the chromosphere.)

As to the Fraunhofer spectrum, the most recent research bearing upon the elements entering into the sun's composition is that of Professor Rowland, who has catalogued close upon twenty thousand lines between wave-lengths 2975.5 and 7331.2 by the use of his splendid concave gratings. Some hundreds of these dark lines owe their origin to the absorbing powers of their own atmosphere, through which the sun is of necessity viewed; but, as a rule, these are readily distinguished from true solar lines by their increased thickness when the sun is near the horizon, by their freedom from the displacement which is common to all true solar lines when the advancing or receding limb of the sun is observed, or by their increased thickness when the air contains a great deal of water vapour. (Fig. 2.)

The chemical significance of the true solar lines is most satisfactorily determined by photographing side by side the spectrum of the sun and that of the substance under investigation. Such a comparison at once shows whether there are any coincidences of the solar and terrestrial lines, and if there is an exact agreement, we are entitled to conclude, in accordance with Kirchoff's law, that the substance in question is present among the vapours which surround the bright shell from which most of the sun's light proceeds. This method was adopted by Sir Norman Lockyer about twenty-five

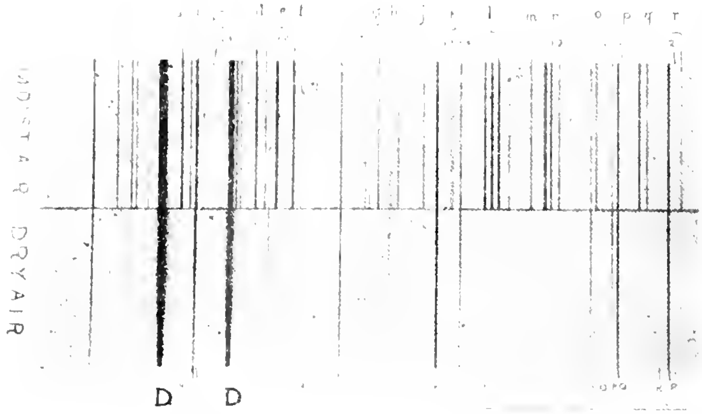


FIG. 2.—A portion of the Solar Spectrum showing intensification of lines due to aqueous vapour in our atmosphere when the air is moist. (Crewe.)*

years ago, and more recently Prof. Rowland has, in this way, compared the spectrum of the sun with that of every known element except gallium. The majority of the stronger lines have now been identified with respect

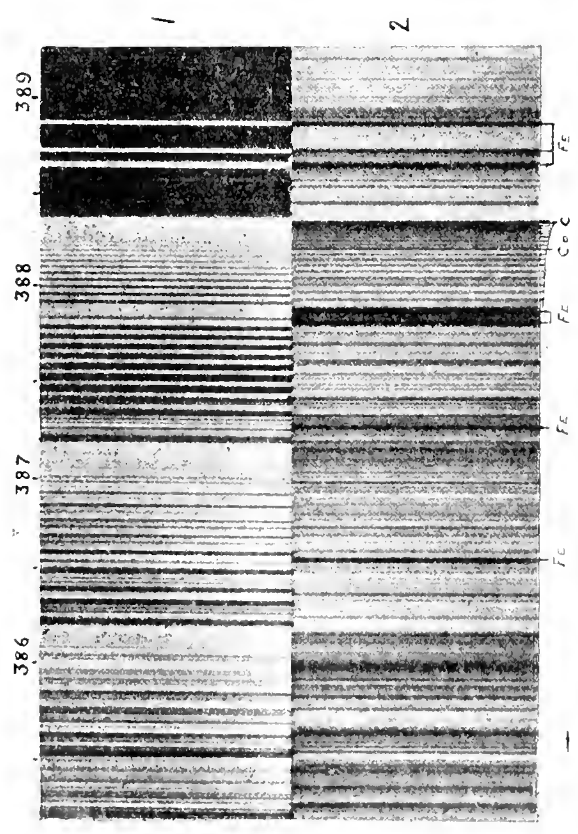


FIG. 3.—A "Solar comparison," showing how the presence of carbon in the Sun is demonstrated. (Lockyer.) (1) Carbon fluting in electric arc, with iron impurity. (2) Solar spectrum

to the elements which produce them. To the substances recognised by Rowland, Messrs. Runge and Paschen† have added oxygen, the presence of which may now be considered as demonstrated (fig. 4), and Hartley and Ramage have added gallium.‡

Some thousands of the Fraunhofer lines, however, still belong to the category of "unknown" lines. Here, then, is a great field for further enquiry, for it is, perhaps, too early to conclude that these "unknown" lines have no terrestrial equivalents, or even that they represent the dissociated products of our terrestrial elements. The latter view in fact appears to some extent negatived by the recent researches of Sir Norman Lockyer, which show that the first stage in the dissociation of a metal is indicated by the appearance of enhanced lines (lines which are brighter in the spark than in the arc spectrum), and in the case of iron and other well-known metals these enhanced lines probably do not appear as

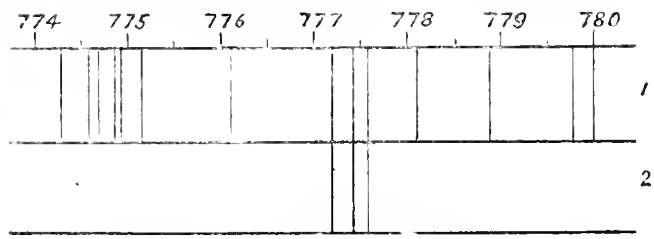


FIG. 4.—The lines of oxygen in the Solar Spectrum. (Runge and Paschen.) (1) Solar Spectrum. (2) Oxygen vacuum tube.

such among the dark lines of the solar spectrum. The substances which we can best compare with the Fraunhofer lines agree in indicating that the absorbing vapours which produce them exist under conditions very similar to those which exist in the electric arc. It may be, therefore, that some of the unidentified lines, which are mostly feeble, represent lines in the arc spectra of known substances which are so faint as to escape detection unless photographs are taken with very long exposures. In fact, the tables of lines recently published by Hasselberg, and by Prof. Rowland himself, for vanadium, chromium, and other elements, leave little doubt that many of the unidentified lines in Rowland's solar tables are to be accounted for in this way.

Another important point also appears to have received insufficient attention. It is by no means impossible that among the constituents of the earth's crust are many still unrecognised elements which exist in such small quantities as to evade the ordinary processes of chemical analysis, but which may yet be revealed to the delicate eye of the spectroscope. As the usual practice in the matching of solar lines is to deal with elements in as pure a state as possible, it would appear important to make a spectroscopic comparison with the sun of substances as they occur naturally in the form of minerals and rocks. Prof. Hartley has, in fact, already found that some of the rarer metals, especially lithium and gallium, are very widely diffused in mineral substances, and this furnishes an excellent illustration of the delicacy of the spectroscopic method. Until such mineral comparisons have been made, it would be unwise to suppose that all unidentified lines of the solar spectrum owe their origin to non-terrestrial matter.

In the investigation of the constituents of the sun, as already remarked, we are not limited to the dark line spectrum. The bright line spectra of the chromosphere and prominences may be examined any time the sun is visible, and by taking advantage of total eclipses, the outlying parts which constitute the corona are opened

* *Astrophysical Journal*, Vol. IV., 1896, page 324.

† *Astrophysical Journal*, Vol. IV., 1896, p. 318; Vol. VIII., 1898, p. 73.

‡ *Astrophysical Journal*, Vol. IX., 1899, p. 214.

to investigation. The photographs taken during recent eclipses, some of which are familiar to the readers of Knowledge, give very complete data as to chromosphere, prominences, and corona, and for our present purposes we may take these as including practically all that is certainly known of these appendages.

These photographs indicate that the chromosphere in its upper parts—five or six thousand miles above the photosphere—consists chiefly of hydrogen, helium, and calcium, while at lower levels we get indications of metallic substances in the numerous lines which constitute the so-called "flash" spectrum. As is now well known, the flash spectrum is not a simple reversal of Fraunhofer lines; while the majority of the principal dark lines probably have corresponding bright lines in the flash spectrum, a great number of bright lines not represented with proper intensity by dark lines make their appearance (fig. 1). Sir Norman Lockyer has traced many of these bright lines to known substances, such as iron, titanium, and so on. He has shown that these previously "unknown" lines of the chromosphere spectrum are mostly lines which become intensified, or "enhanced," when we compare a spark with an arc spectrum of the same substance, and in the present stage of the inquiry it is supposed that the enhancement of these lines is due to the higher temperature of the spark. If we grant that the region which produces the flash spectrum is at a temperature higher than that which by its absorption produces the Fraunhofer lines, we not only have a pretty complete explanation of the origins of the lines, but we have a reason for the want of similarity between the flash and the Fraunhofer spectra. So far as there is any similarity between the two, it may reasonably be ascribed to the fact that the same substances are involved in the production of the dark and bright line spectra, and that many lines persist through a great range of temperature. But whatever may be the physical explanation, the discovery of the enhanced lines, aided by that of helium, removes a great deal of the supposed non-terrestrial matter from the chromosphere, and there is probably now no greater a percentage of unfamiliar lines in the chromosphere than in the solar spectrum itself.

The spectra of the prominences show that the substances present are the same as those which exist in the chromosphere, no additional elements being certainly indicated.

When we come to the corona, however, we have still to acknowledge ourselves in the region of the unknown. First and foremost in its spectrum is the green line which has, until quite recently, been known as 1474K, but which we now know to be much more refrangible than this line. Photographs taken at Viziadrug, India, in 1898, (fig. 4), show that while the bright 1474K line is truly chromospheric (Lambda 5316.79) and corresponds to an enhanced line of iron, that of the corona has a wave length 5303.7,* and has not yet been identified, unless Prof. Nasini's supposed new gas from Pozzuoli turns out to be its terrestrial equivalent. As to the other coronal lines which have been photographed during recent eclipses, no satisfactory evidence as to their origin is forthcoming, but the discovery of helium encourages us to hope that the coronal gases will be also eventually found upon earth.

In the present state of our knowledge it does not seem possible to give a perfectly trustworthy list of the elements certainly present in the sun. One published by Rowland, in 1891, is the most extensive, but the more recently published tables do not seem to afford complete justification for it. Taking the tables, however, and including oxygen, gallium, and the chromospheric and coronal gases, we may summarise the most probable elements as follows:

Aluminium	Hydrogen	Potassium
Asterium†	Helium†	Scandium
Barium	Iron	Silicon
Cadmium	Lanthanum	Silver
Calcium	Magnesium	Sodium
Carbon	Manganese	Strontium
Cerium	Molybdenum	Titanium
Cobalt	Neodymium	Vanadium
Copper	Nickel	Yttrium
Coronium*	Oxygen	Zinc
Chromium	Palladium	Zirconium

In addition there is evidence which suggests the possible presence of the following elements:

Beryllium	Mercury	Ruthenium
Didymium	Niobium	Thallium
Erbium	Platinum	Tin
Indium	Rhodium	Tungsten
Lead		

Besides these, Rowland, in his 1891 list, includes germanium and glucinum among the elements present, and iridium, osmium, tantalum, thorium, and uranium among those doubtfully present, while Lockyer concluded that lead and uranium were certainly present, and lithium, glucinum, rubidium, cæsium, and bismuth probably present.

It will be seen that the constituents of the sun approximate to those of our own earth, and Prof. Rowland was probably not far from the truth when he remarked some years ago that "were the whole earth heated to the temperature of the sun its spectrum would probably resemble that of the sun very closely." In each case our knowledge is fragmentary. Our terrestrial chemistry is but skin deep, and our solar chemistry is only that of the sun's atmosphere, for we as yet know nothing either of the interior of the earth or of the vast region which lies beneath the sun's photosphere. It must be borne in mind also that as regards the sun our knowledge is limited to the indications of the spectrum, which in the case of a mixture of substances may render no account of some of the elements present. Thus, although we are not yet in a position to assert that the composition of the sun is identical with that of the earth, it would not be easy to justify the view that there is any fundamental difference.

[For the use of figures 1 and 3 we are indebted to Sir Norman Lockyer, and for figures 2 and 4 to the editors of the "Astrophysical Journal."]

"TREES STRUCK BY LIGHTNING."

By Howard B. Little.

Throughout the past year correspondence has been carried on under the above heading in Knowledge. It was in January last that "A. C." gave an account of an elm tree which had been practically shattered by the dread stroke; and he asked "What actually takes place? What is the force exerted?" In the following month, again on the correspondence page, I answered these questions to the best of my ability, pointing out that our ascertained facts were few, but that electro-

* Roy. Soc. Proc., Vol. LXIV., p. 168.

* In corona only. † In chromosphere only. (Asterium and helium, according to Lockyer, are the two constituents of the cleveite gas.

lytic action, combustion, and violent evaporation were doubtless all present. I further suggested that the assistance of Botanists was required for the complete solution of the problems.

In the October number of KNOWLEDGE a most interesting letter from Baron Kaulbars was published. Here much detail was given concerning the fate of various trees, as also an account of the destruction of a stone monument which was, at intervals, braced internally by iron angles. But strangely enough the writer, in giving his conclusion (which, to save space I will write "steam"), altogether overlooks the terrific force in Nature—Electro-chemical action. Further, while he says that a very old dry tree may be burned down he seems to overlook the fact that the insulator resin is highly inflammable. Again, one finds it difficult to suppose that in the case of the tower the path of the lightning was from iron to iron. If however this was actually so, we are confronted with a remarkable difficulty to which I shall refer later.

Next, in November last, Lord Hampton, after endorsing the statements made by Baron Kaulbars, states that upon one occasion (of which details are given), Faraday, pronouncing upon a smitten tree, asserted that the lightning had gone down the hollow stem and, meeting with damp at the bottom, generated steam, so causing an explosion. Now, with all deference, I would submit that there appears to be an error here. Faraday knew well enough that the resistance of air is enormously higher than that of any wood. By air I mean of course air at more or less normal pressure. Why then did the lightning seek the path suggested? We must regard trees as being in a measure lightning conductors. This brings me to the undeveloped argument suggested by the case of the tower which Baron Kaulbars mentioned. Did the lightning follow a track (which was in all probability tortuous) through each piece of iron, going always from one to that next it? I doubt it. But of this more anon.

A few days since the Editors handed me two letters which they had received recently upon this question. The first, signed E. W. Mitford, gives very many instances of trees having been struck. His first case is that of an Elm, and the damage done he describes as having been via "several serpentine channels through the bark, and reaching half way up the tree from the ground." Now this serpentining is not difficult to account for (it was mentioned in October), the fact being that the current goes from point to point by the easiest route. But why the suggestion of "from the ground"? The idea of return shock, or earth's potential is difficult of conception here. A tree may easily enough be struck, first, half way up its height, and further, there cannot be much doubt that the trees are less susceptible to damage (of a serious nature) at their tops. The same correspondent remarks that he has frequently seen lightning rise in a tapering pillar from the earth. This is no doubt the so called "Luminous Rain." Oh that I had space to deal with it here.

The next letter is that of "An Old Rug." May his hearth never grow cold!" He, dating from Jamaica, tells how the top of a tree was taken off and carried away with tremendous violence. The branches too were cut off and strewn round a hole in the earth where the root had been. (I want in this connection one detail—was the hole lined with earth in its normal condition, or was there a sleeve of vitrified sand?) The trunk of the tree was completely shattered. That is to say here again the top was only injured by removal.

Finally, in the December issue, P. de Jersey Grut gave particulars of a case which is perhaps more interesting than any yet cited. In this instance the tree struck was encircled by a rope some twenty-five feet from the ground, and it so chanced that an end of the rope stood out from the bark of the tree, so that during the earlier part of a rain-storm the tree was damp from the top to the rope, while the lower portion of the trunk was kept comparatively dry. The tree in this condition was struck, the lower part only being damaged. And the damage followed, downwards, a path which the twist in the fibre of the wood made easiest.

And now, endeavouring to gather up those thread ends which I am painfully conscious of having scattered; the methods of lightning seem erratic. The word "chance" is all too often misunderstood; it really means the natural effects of causes which were unexpected, or even unknown. And lightning moves at a speed that is literally beyond our ken, save for figures which convince only the few.

From all this then, I propose, in conclusion, to venture upon one or two bold statements. Suppose an enormously powerful magnet to have been erected, several feet above a building, and further suppose that the surrounding air be filled with flying masses of steel moving "like lightning." What would be the result? Would the steel that came near go to the magnet? Some might, but, remembering the pre-supposed (lightning) velocity many of these masses would swerve from their paths if they were sufficiently near, and go crashing through the roof. In other words, a lightning conductor may often bring destruction just near enough to destroy that which it has been set up to protect. And a tree top may bring the lightning to its own immediate neighbourhood, yet, not quite to itself, so that it is not extraordinary if the tree be struck in the middle.

I am painfully conscious that I have not done justice to my subject. But, as a lightning conductor, I seem to have drawn towards me a vast deal of (may I say matter?) with which I cannot deal. Careful observation, and well recorded data are still at a premium.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

"IS THE STELLAR UNIVERSE FINITE?"

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In his interesting papers on the above subject in KNOWLEDGE (July and November), Mr. Burns has neglected three factors which, I think, must be taken into consideration. These are (1) the absorption of light by our atmosphere, and (2) by our object-glasses or mirrors, and (3) the finite sensibility of our eyes and photographic plates.

Suppose for a moment that all stars consists of two degrees of intrinsic brightness, their differences in photometric magnitude being otherwise due to differences in distance, and that stars are uniformly distributed through space. Then with a given aperture we are able to see every star within a sphere the radius of which is equal to the greatest distance at which a star of the second (the fainter) degree of intrinsic brightness can only just be seen by reason of the three factors mentioned. Outside this sphere we have a shell the external limit of which is the maximum distance at which a star of the first degree of intrinsic brightness is just visible, and within this shell only stars of the first degree of intrinsic brightness will be visible with the same aperture. But will an increase of aperture render visible all the stars of the second degree of intrinsic brightness, i.e., all the stars lying within the shell? It will not, because some of the stars—viz., those near the outer surface of the shell—will be so faint that their feeble rays will be either entirely absorbed, or so much absorbed by our atmosphere and telescope, that the limited sensibility of our eyes or photographic plates will be unable to show them. But it may be argued that these second degree stars may be bright enough to be seen with the larger aperture even from the outer surface of the shell. This may be true in the limited case we are considering, but not when we consider infinity.

In all probability stars consist of 100 or 1000 degrees of intrinsic brightness. We must therefore consider 100 or 1000 shells around the inner sphere, in each succeeding one of which, with a given aperture, fewer stars are seen. If the feeble rays from a star of the 100th degree of intrinsic brightness be just able to penetrate our atmosphere from, say, the 50th shell, then all the 100th degree stars beyond this distance will be quite invisible with any aperture. Stars of the 100th and 99th degrees of intrinsic brightness will be visible beyond the 51st shell; those of the 100th, 99th, and 98th degrees beyond the 52nd shell, and so on till we come to the 150th shell, where stars of the 1st degree of intrinsic brightness become invisible, and which therefore forms the limit of the visible stellar universe. Must we not, then, expect a thinning out of faint stars somewhat similar to that shown in fig. 2, p. 154 (July)? And may we not therefore brush away those "clouds of cosmical dust which conceal eveything beyond" our faintest stars?

But, even disregarding absorption altogether, is the question of sky-light from an infinite number of stars so simple as Mr. Burns assumes? Someone has defined "nothing" as "a bung-hole without a barrel"! Similarly, a star at infinite distance is a star without a magnitude. For if it be at infinite distance it must be infinitely faint, and its disc infinitely small, i.e., like a geometrical point, without magnitude. How, then, can an infinite number of such points cover anything at all, much less the entire sky? And again, could the light of a star at infinite distance ever reach us? Would not the star be at a finite distance if it did? Nor will the excessively faint stars that are at finite distances produce any apparent brightness, for the image of each star falls upon a different point of the retina; and since each is invisible, they will be collectively invisible.

Must we not therefore conclude that although the stellar universe may be infinite, the visible portion of it must be finite; and that no reasoning, from numerical data or otherwise, can ever advance us a step further?

It seems to me that the question is not "Is the stellar universe finite?"—that we can never know—but "Is it probable that within the finite visible universe stars are uniformly distributed?"

Madeira. Wm. Anderson.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Having read the article in last month's issue under the above heading, it occurred to me that the writer, Mr. Burns, would go a good way in answering the question if he were to define in what sense he uses the word "infinite."

When scientists speak of the number of the stars being infinite, they either mean indefinite, or give to the word its strict philosophical meaning. Taken in the first sense the word infinite is quite intelligible as applied to the number of the stars, man's power of observation being so limited. To adopt the second sense is to put forward an absurdity.

It is scarcely necessary to observe that the idea of infinity in the strict sense does not admit of circumscription; of either increase or decrease; and accordingly excludes the idea of extension or multitude.

Surely this sense of the infinite cannot be predicated of the stellar universe, made up as it is of units.

R. J. Connell.

[Mr. George H. Hill (Streatham), writing on this subject, "Is the Stellar Universe Finite?" challenges Dr. Burns' conclusion (Knowledge, November, 1899, p. 249), that "if the number of stars were infinite we should have the whole sky one blaze of light," on the ground that Dr. Burns assumes that what is lost in stellar radiation by distance, is gained in number. He writes:—"But if the illuminating area were to decrease owing to increase of distance, more rapidly than it increased, owing to greater numbers, surely however infinitely the process might be continued it would never give us a blazing sky." This is of course true if the rate of decrease be sufficiently high, and simply expresses in other words my own criticism of Dr. Burns' fourth hypothesis. Mr. Hill gives my suggestion more at length, and conceives of space "as containing practically isolated stellar groups or systems (on a colossal scale), every star visible to us belonging to but one such system, while other (exterior) systems appear to us only in the form of nebulæ." He further suggests that there would naturally be a tendency to thin out towards the margin of such a system, in accordance with Mr. W. H. S. Monck's remark (Knowledge, August, 1899, p. 179) that "a thinning out commences at (comparatively speaking) no great distance from the earth or sun." It must be borne in mind that the idea that the irresolvable nebulæ were "external galaxies" was refuted long ago by Herbert Spencer, Proctor, and others. The clustering of nebulæ round the poles of the Milky Way is a clear proof that they form an integral part of the same structure with it; as their occurrence with stars in the Nebecula Major is a proof that they exist at substantially the same distances from us, as do the stars.]

The "Seas" of the Moon.—Mr. James Macgeorge criticises Mr. J. G. O. Tepper's paper on "The 'Seas' of the Moon" (Knowledge, November, 1899, p. 251), on the ground that Mr. Tepper has not shown that the Moon ever had an atmosphere sufficiently dense to support any form of organic life, and calculates the amount of atmosphere which it would have possessed had it attracted to itself a proportion of atmosphere, as compared with that of the earth, corresponding to its gravity. As the figures may be of some little interest I give them here more precisely than Mr. Macgeorge has done. Taking the diameter of the earth as 7,926 miles and of the Moon, 2,160 miles; we have the earth 3.67 times the Moon in diameter, or 13.47 times in surface area. Its mass, however, is 78 times as great. If then the total mass of the earth's atmosphere be 78 times that of the Moon we shall have 5.8 times the amount of atmosphere above each unit of the surface here, that there is on the Moon. But this atmosphere will be differently distributed. Half of our atmosphere is passed through when we ascend 3½ miles from the earth's surface. To pass through half the Moon's atmosphere we should have to ascend 23 miles. At 10½ miles therefore above the surface of the two worlds we should find the same amount of atmosphere above us in both cases, and at 21½ miles the actual density of the atmosphere would be as great for the Moon as for our earth, though at the surface of the ground the pressure at the earth's surface would be 37·6 times as great as on the Moon. Above 21½ miles high the entire advantage would rest with the Moon. Now the earth's atmosphere is sufficiently dense far higher than this to vaporize meteors by the resistance which it offers to their path, and to produce strong crepuscular effects. We have no evidence of an atmosphere approaching this in efficiency, on the Moon. It seems clear then, that the Moon has not, at present, the proportion of atmosphere to which its mass entitles it. If it never had more than at present we must agree with Mr. Macgeorge that "the theory of vegetable remains necessarily falls to the ground." But seeing how little we know as to the condition and extent of the earth at the time when the lunar crust had become solid and cool, or of the distance apart of the two bodies at the time, it is certainly rash to say that the Moon may not then have had a respectable atmosphere. As to what has become of it since, we most certainly cannot agree with Mr. Macgeorge that "it is impossible that it may have been attracted by the earth," nor is it "inconceivable that it may have been absorbed by the substance of the Moon." Neither hypothesis is, however, necessary, for Dr. Johnstone Stoney's researches tend to show that the Moon has not sufficient attractive force to retain permanently an atmosphere of constituents similar to those of our own; and assuming that the Moon once had a comparatively dense atmosphere, this would necessarily fully explain its present disappearance.]

[COLLECTING METEORIC DUST.—Messrs. T. S. Overbury and L. B. Booth enquire how the Rev. J. M. Bacon collected meteoric dust by means of gun-cotton during his recent balloon voyage to observe the Leonids. The answer is of the simplest. A continuous current of air was drawn through a tube in which a small plug of gun-cotton was fixed, which would act as a filter to filter out any dust which it might contain. The gun-cotton could easily be dissolved at the end of the voyage, and the amount and character of the dust which it had taken up, if any, be ascertained.

[E. WALTER MAUNDER.]

ACIDS IN SOIL.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Will you be so good as to inform me if there exist in any part of England or Ireland marshy soils, or rather mineral moors, which contain besides sulphuret and peroxide of iron:—organic acids such as formic acid or acidity, and if so in what proportion to the other ingredients.

South Tottenham, Dec. 12th, 1899. W. A. SMITH.

Obituary.

SIR J. WILLIAM DAWSON, whose death on 19th November, 1899, we regret to record, was a leading man of science of the old school—a teacher who stoutly supported the final destiny of man as taught in Revelation, and emphatically opposed to all theories of the evolution of man from brute ancestors, nor would he allow anything more than a moderate antiquity for the species. Of Scottish extraction, he was born at Pictou, Nova Scotia, in 1820, obtained the degree of M.A. at Edinburgh in 1842, then recrossed the Atlantic, and spent some time in scientific exploration under Sir Charles Lyell's direction. Papers contributed to the Geological Society of London soon brought him into prominence. In 1855 he was appointed Principal of McGill University, Montreal, only excelled in America by that of Harvard, and the scientific side of that institution was practically Sir William's creation. The Royal Society of London in 1862 elected him a fellow, and twenty years later he received the Lyell Medal of the Geological Society of London. In 1884 he was made a K.C.M.G., in 1886 he discharged the duties of President at the Birmingham Meeting of the British Association, and he was the first President of the Royal Society of Canada. Eozoon Canadense, described by him in 1865, opened a controversy on organic life which is not yet entirely disposed of. The study of Geology he would have "delivered from that materialistic infidelity which, by robbing nature of the spiritual element and of its presiding Divinity, makes science dry, barren, and repulsive." "Modern Science in Bible Lands," "Eden Lost and Won," among his many popular books, indicate the trend of his teaching. Sir William's solid contributions to science in the form of papers to learned societies, periodicals, and magazines, were very numerous, those to our own Royal Society numbering one hundred and fifty-eight.

SIR HENRY TATE, whose death occurred on the 5th December, 1899, will be remembered as a successful man of business who utilised his great wealth in promoting the interests of science and art. "This gallery and sixty-five pictures were presented to the nation by Henry Tate for the encouragement and development of British Art, and as a thank-offering for a prosperous business career of sixty years." So reads an inscription affixed to the base of a column in the vestibule of the magnificient pantheon of Art on the banks of the Thames erected on the site of Millbank Prison. Sir Henry endowed many scholarships, contributed £10,000 to the building fund of Owen's College, and donations to the extent of some £50,000 to University College, Liverpool. Born at Chorley, Lancashire, in 1819, he served an apprenticeship to the grocery trade, and subsequently engaged in sugar refining—a business which, under his shrewd management, rapidly expanded to gigantic proportions, and "Tate's cube sugar" became a familiar object all the world over. As his wealth augmented he freely utilised it in the stimulation of education and in patronising artists. Previous to the opening of the Academy Exhibition each year he gave a great dinner at Park Hill, Streatham, to the leading artists, and in course of time he acquired by purchase a collection of the works of British Artists of the day, which gradually led him up to the idea of forming a permanent home or Gallery thoroughly representative of British Art. He offered £80,000 to build a gallery, provided the Government would give a site. Vacant land near the Embankment at Blackfriars was declined by the City Corporation, and a site at South Kensington had already been promised for a new science college and museum, but, at last, Sir William Harcourt, in 1892, then Chancellor of the Exchequer, offered the site at Millbank. The Tate Gallery was opened 21st July, 1897, and so recently as 27th November, 1899, the opening of a new wing completed the great building which British Art owes to Sir Henry Tate's munificence.

Science Note.

Royal Institution. The following are the Lecture Arrangements at the Royal Institution before Easter:—Mr. C. Vernon Boys, Six Christmas Lectures (especially adapted for young people) on Fluids in Motion and at Rest; Professor E. Ray Lankester, Twelve Lectures on The Structure and Classification of Fishes; Dr. W. H. R. Rivers, Three Lectures on the Senses of Primitive Man; Professor H. H. Turner, Three Lectures on Modern Astronomy; Dr. Charles Waldstein, Three Lectures on Recent Excavations at Argive Heræum (in Greece); Three Lectures by Sir Hubert H. Parry; Mr. W. L. Courtney, Three Lectures on The Idea of Tragedy in Ancient and Modern Drama; The Right Hon. Lord Rayleigh, Six Lectures on Polarised Light.

Notices of Books.

Handbuch der Astronomische Instrumentenkunde. A description of the instruments used in astronomical observations, together with an explanation of their construction, their application, and their mounting, on fundamental principles. By Dr. L. Ambronn. Two volumes, containing 1185 figures in the text. (Berlin: Julius Springer. 1899.) Dr. Ambronn has produced a work which is unique of its kind, and which will, beyond doubt, be regarded as classic. From time to time our great instrument makers in England have published catalogues of their telescopes and mountings, and perhaps a full description of their properties and the methods of making and adjusting them, but these cannot for a moment compare with the encyclopaedia of instruments and instrumental adjuncts that has just been compiled by Dr. L. Ambronn. In Germany, Carl wrote, about 1860, his "Principien der Astronomischen Instrumentenkunde," and, twenty years later, Von Konkoly his "Anleitung zur Ausfuhrung Astronomischer Beobachtungen"; and, quite lately, Professor E. Becker has produced a monograph on the "Mikrometer"; but these may be regarded as simply introductory to Dr. Ambronn's work. The two volumes contain together some 1276 pages, and are divided into seven chapters. The first chapter treats of the adjuncts of an astronomical instrument—screws of all sorts, both for clamping, for correcting and motion, and for measuring; plummets and levels; artificial horizons, collimators and verniers, and reading microscopes. All these are very copiously illustrated; and Dr. Ambronn has not confined himself to a mere description of them by word or woodcut, but discusses their properties, their errors, and the necessary corrections for these, whether by mathematical or by instrumental means. The second chapter takes up the question of the recording and noting of time, whether by clock or chronometer, by pendulum, hair spring, or electric control; the regulation of motion and compensation. Chapter three is divided between three large subjects. The first has to do with the axes of a telescope, and the supports on which they rest or in which they turn. The second division takes the two great forms of instrument with which telescopic work may be done—the refractor and the reflector. In the case of refractors, there is a very full description of the manner of choosing the glass, the grinding and figuring of the lenses, and methods of combining the lenses of different glass and different form to make the finished objective. The mounting of the objective in its cell is not omitted, nor the effect of the whole on the form of the stellar image. The methods of figuring and polishing, or silvering [illegible] different forms of reflecting telescopes, are [illegible] The third division tells of the constructing and [illegible] circles and of the determination of their errors, and [illegible] devoted to clamps and slow motions. The fourth [illegible] 1?0 pages, takes the micrometer in all its forms, [illegible] simplest focal micrometer to the great Radcliffe and [illegible] micrometers. It is a very great gain that these important [illegible] are so fully figured. The next two chapters comprise [illegible] the whole of the large second volume consist of description of the important instruments of the world, which are remarkable for their size and power, or for their perfect or ingenious form of mounting, or for their adaptation to some particular object. We find here the photometers of the Harvard Observatory, of Steinheil, Knobel, and Pritchard; the measuring apparatus of Kapteyn; the meteor camera of Elkin; the great refractors of Yerkes and Lick; the elbow form of mount in use at Potsdam; the twin telescopes of Greenwich; the great reflector of Dr. Isaac Roberts. Incidentally, Dr. Ambronn mentions that the chief reflectors are made and used in England, the exceptions being those of Professor Safarik, at Prague, and of the well-known optician, Dr. H. Schroder. The final chapter is devoted to the housing of the telescopes. Pretty nearly every sort and shape of dome is figured and described. The omissions are very few and slight. We are sorry not to see any description of the properties, or use for astronomical purposes, that the portrait lens has been put to by Professor E. E. Barnard and others. There are, also, one or two special forms of photographic objectives which apparently are not described—notably a very short focus portrait lens by Voigtländer and Sohn, and Mr. J. H. Dallmeyer's stigmatic lens. Perhaps the section which is the least completely dealt with is that of the spectroscope, which is at once one of the most intricate and one of the most important of the telescope accessories. The objective-prism, in particular, is very briefly treated of. But these are but small points, and cannot detract from the immense value of the book as a whole. It will form an invaluable adjunct to the library of every observatory—for the whole wide field of astronomical instruments has been covered with conspicuous skill, thoroughness, and care—and it will be a complete reference book to any astronomer who wishes to establish a telescope of his own, even though his equipment be necessarily a modest one.

The Natural History of Selborne. By Gilbert T. White. Edited with Notes by Grant Allen. (John Lane.) Illustrated. XII. Parts. 1s. 6d. each. It is pleasant to think that among the last literary work undertaken by the late Grant Allen was the editing of an edition of White's classic letters. That this was a most congenial task to Grant Allen we are certain, for he knew the neighbourhood of Selborne well, and was a great admirer of the immortal Gilbert White. Although—as the editor says in his delightful introduction to the volume—these "letters have probably been reprinted in a greater number of editions than those of any other English worthy," nevertheless their present edition is very welcome. The aim has been to preserve the original text; and the editor's notes, which are useful and not unnecessarily frequent, are always signed, and can, therefore, be immediately identified. No attempt has been made to bring all White's statements up to the modern standard of scientific knowledge—and rightly, for such a gigantic task would utterly spoil the book. Everything in this edition—from the editor's scholarly introduction to the excellent pen-and-ink drawings by Mr. Edmund H. New—is in keeping with the character of the letters. An appendix contains a novel feature in some interesting marginalia from Samuel Taylor Coleridge's copy, as well as a complete bibliography of the work.

Bacteria. By George Newman, M.D., F.R.S. (Murray.) Illustrated. 6s. Dr. Newman, according to the preface in this book, had no other inspiration than an editor's [illegible] to set forth a popular scientific statement of [illegible] knowledge of bacteria," when he undertook to [illegible] one more to the large number already in existence. [illegible] this sort of halter round one's neck it is a hard [illegible] traverse the uneven ground covered by that [illegible] yet innocent looking, word—bacteria. As the [illegible] is difficult to escape the Scylla and Charybdis [illegible] voyage." Too technical for the many and too popular for the few, one or other of these results is often a [illegible] of this kind. A medical student, in his third or fourth year, would follow Dr. Newman with profit, but the average man depending upon [illegible] and *minus* the buoyant auxiliaries of science, could hardly sustain the voyage from cover to cover. The word "popular" can hardly be applied to a book in order to understand which the reader must know the nomenclature of the chemist, the phraseology of the dissecting room, and the out-of-the-way language of many other specialists in different domains of science.

Curiosities of Light and Sight. By Shelford Bidwell, F.R.S. (Sonnenschein.) Illustrated. 2s. 6d. Consists mainly of matter presented in the form of lectures at various places, but here remodelled for a larger public. Of a popular and informal character, as might be expected in such a case, the essays, as we may now call them, bring into relief such phenomena as defects of the eye, optical illusions, curiosities of vision, and so on, subjects which appeal more particularly to the spectacled section of the community. Heavily leaded type is used, and a fair-sized volume is thus eked out of an almost starvation supply of intellectual food.

Views on some of the Phenomena of Nature. Part II. By James Walker. (Sonnenschein.) 2s. 6d. Our author has selected for his theme all the inexplicables—force, motion, space, ether, light, heat, electricity—and courageously attempts to fly in this attenuated atmosphere, so to speak. One needs to be very wide awake in order to glean a little mental food here and there in this arid desert; but now and then it is possible to drop across an oasis—fertile, refreshing, new. For example, "light and the sun's photosphere are one," "light is the sublimed product from matter in an incandescent state," and light is "projected into space by some disruptive force developed on the sun's surface."

Sport in East Central Africa. By F. Vaughan Kirby (Maqaqamba). (Rowland Ward.) Illustrated. 8s. 6d. This book, dealing with several hunting trips in the wilds of Portuguese Zambesia and the Mozambique Province, is full of the most stirring incidents connected with big game shooting that can well be wished for, told in the most matter-of-fact way imaginable. It is not to be inferred from this that the author has been guilty of giving us "travellers' tales," or even of stretching a point; indeed, we believe every story he tells. And as to his matter-of-fact style, we admire it, and think that it adds very greatly to the interest of the book. It is, in fact, the style—a rare one—in which all books of big game shooting should be written. That Mr. Kirby is a true sportsman—and not a wanton destroyer of animal life—and a brave and resourceful man to boot, is testified by many a page of his engrossing and exciting narrative. A very useful appendix to the book contains interesting and informing field notes on all the larger animals—and there are many—obtained by the author in the region of which the work treats. We heartily recommend the book not only to sportsmen, but to those who are in any way interested in East Central Africa, for the author knows the country and its people well, although, perhaps, his knowledge of them is not so intimate as that of the wild animals for the hunting of which he has lived.

The Social Life of Scotland in the Eighteenth Century. By the Rev. Henry Grey Graham. Two vols. (A. & C. Black.) 24s. To draw an indictment against a nation has always proved at once an easy and a popular task, no matter how poor the grounds of the charge, or how remote from the facts. There are few people in the world who have suffered more odium in this way at the hands of the impecunious scribbler than the race across the border. But Scotland has incurred a lasting debt of gratitude to the author of these fascinating volumes for the comprehensive acumen with which he has exploited the records of the past, placing in our hands a delightfully vivid picture of Scottish life and Scottish manners in the last century. Mr. Graham has essayed to give us history in its most instructive form—to bring before his readers the life of the whole people, rich and poor, lairds and labourers, as they lived it. The goal which he has set himself is the worthiest in the historian, and our author has justly followed his course to the end. "It is in the inner life of a community that its real history is to be found—in the homes and habits and labours of the peasantry; in the modes and manners and thoughts of society; what the people believed, and what they practised; how they farmed, and how they traded; how the poor were relieved; how their children were taught, how their bodies were nourished, and how their souls were tended." Thus the task. But at what infinite pains of research, of sifting and sorting, of weighing and counting, has that task been accomplished. Apart altogether from the great reach and number of the authorities consulted, what countless documents, letters, bills, pamphlets, and kirk session records have been laid under contribution, as these entrancing glimpses of that far away time are unfolded before us. Not the least among the virtues of the work is the thoughtful orderliness and compactness of the picture as a whole—the artistic limning of that peaceful revolution which brought the impoverished country and people onward and upward in every channel of national activity. If it be not invidious to single out any portion of a book in which we have not found a dull page, we may be permitted to direct attention to the chapters on The Land and the People, on Education in Scotland, and to the happy and entertaining account of Town Life in Edinburgh. In this latter chapter the author realises most vividly the later period of the greatness of the old town, in whose dark recesses, Lord Rosebery has told us, are embodied three-parts of the history of Scotland—when the High Street was the daily meeting place of judges, ministers, and advocates, when lords of Session resided in the Canongate, and resorted at night to the Crochallan Club, so famous for its association with Burns, or might be found at John Dowie's tavern. We do not know a better account of this intensely interesting chapter in the life of Auld Reekie. In taking a regretful leave of Mr. Graham's book, which is sure to become a standard work in Scottish history, we can but hope that the unique success which has crowned his labour in the preparation of these two volumes, may induce him to write the necessary third volume on the Literature and Fine Arts of the Century, for which he must have amassed a quantity of material. Without such a volume the work is scarcely complete.

Star-land. By Sir Robert Stawell Ball, F.R.S. (Cassell.) 7s. 6d. It almost makes one long to be a child again, and to have the right to form one of Sir Robert Ball's audience at his Christmas lectures at the Royal Institution, to read the new edition of "Star-land." Sir Robert has a charm of style and a gift of words that go far to make the hard things of astronomy easy, and the abstruse problems plain; and where there is a bit of the way of knowledge that seems dull or uninteresting, he has an anecdote or an illustration that carries one over the dreary part with a rush. The very largest part of the book tells of that portion of the stellar universe which is comprised within the limits of the solar system; and, perhaps, it is a slight indication of Sir Robert's Hibernian origin that has led him to adorn the cover of "Star-land" with a very beautiful golden representation of the corona and comet of 1882. Speaking of coronæ, it is just a little bit of a pity—after Sir Robert Ball has explained to the children that the size of an object depends very largely on its proximity, and that very serious consequences would result to the temperature of the earth if it was brought closer to the sun—that, on p. 40, in Trouvelot's drawing of the eclipsed sun of 1883, he should have brought it so alarmingly near. The original representation in "L'Astronomie" was considerably exaggerated, but Sir Robert's copy is like Creusa's ghost in Virgil's description, *nota major imago*. There is one point on which Sir Robert Ball speaks with assurance, but on which we have not been able to gather any direct or first-hand evidence. On p. 57 he has a representation of a man standing inside and at the base of a very tall chimney, and below is the description, "How the stars are to be seen in broad daylight." Is it really so, and how many stars, and of what magnitude, can be seen thus?

Colour: A Handbook of the Theory of Colour. By George H. Hurst, F.C.S. (Scott, Greenwood & Co.) Illustrated. 7s. 6d. Artists, dyers, calico printers, and decorative painters, who are accustomed to use pigments in their everyday work, will find in this book a valuable compilation on matters concerning every phase of colour—its production by the decomposition of light, theories of colour phenomena, physiology of light, contrast of tone, decoration and design, and measurement of colour, or the expression of different tints by numbers so that any given shade of colour can be reproduced from data preserved in notebooks or received from other sources. Some excellent plates largely augment the value of the work.

Wild Life in Hampshire Highlands. By George A. D. Dewar. (Dent & Co.) Illustrated. 7s. 6d. This is one of the handsomely bound and luxuriously printed volumes of the Haddon Hall Library now being issued under the editorship of the Marquess of Granby and Mr. Dewar. The Hampshire Highlands lie in the north west corner of the county, a part little known to the tourist. The author's pleasantly written description of the spot he loves so well, and his engrossing account of the many country pleasures to be enjoyed there, makes one wish to visit the district. Although there is perhaps nothing new in the author's observations, we have derived much peaceful pleasure in the perusal of the well-told experiences, anecdotes, and observations of this keen field naturalist and sportsman. The illustrations are like the letterpress—restful and most soothing.

Chats about the Microscope. By Henry C. Shelley. (Scientific Press, Ltd.) Illustrated. 2s. A little book intended to enlist the interest of aimless pedestrians in country places who sacrifice the pleasure and instruction contained in every mossy bank, every darkling pool—the happy hunting-ground freely accessible to all who will but avail themselves of the key to Nature's precious casket. The book is but a slender introduction to pond life, diatoms, foraminifera, and a few other kindred subjects; lacking the sequence necessary as a basis of pure scientific study, it is better adapted as a guide in using the microscope incidentally as a source of innocent amusement. The illustrations are anything but attractive—the "porous cells of mosses," for example, figured on p. 60, look as stiff and mechanical as if intended as a working drawing for the making of book-shelves.

Darwinism and Lamarckism. By F. W. Hutton, F.R.S. (Duckworth & Co.) 3s. 6d. net. Apparently this book consists of a verbatim report of four lectures delivered, in part, as far back as 1887. A great part of the old ground is traversed once again, and little, if any, additional light is shed upon the all-absorbing subject. What is new may be termed the bearer of the candlestick, Mr. Hutton himself, who contrives to project the luminous rays into the holes, corners, and crooked by-ways of the fabric raised by Darwin, Lamarck, and the thousand-and-one workers who have followed in the footsteps of these illustrious pioneers. The best we can say of the book is that it is a handy bird's-eye view of evolution in the wider sense of that term.

Common Sense Health Reform. By T. Thatcher. With supplementary article on "The Gospel of the Open Window," by the Hon. Auberon Herbert. (Simpkin, Marshall & Co.) 2d. Mr. Thatcher is a hero, we know, and not alone because Mr. Auberon Herbert has told us so; but we are not quite sure that a calm consideration of the long vista of trapeze bars, horizontal bars, stirrups and rings, punching balls, and divers developers which Mr. Thatcher opens up before us, will not be held to constitute him a martyr as well. But his efforts are made in the best of good causes—that of robust health: and we heartily commend this description of his experiences to all in search of health guidance.

On the Utility of Knowledge-making as a Means of Liberal Training. By Professor J. G. Macgregor, of Dalhousie College, Halifax. (Nova Scotia Printing Co., Halifax, N.S.) We are obliged to Professor Macgregor for sending us a copy of his informing inaugural address on a subject of so much interest to KNOWLEDGE.

We have received Messrs. T. Cooke and Sons' illustrated catalogue of telescopes, transit instruments, spectroscopes, chronographs, micrometers, driving clocks, observatories, and other astronomical and scientific instruments. As is well known among practical workers, there is now a tendency among some makers of these instruments to lower prices at the expense of quality in workmanship, but this firm proceeds on the principle that "it is impossible to do good work at the cost of bad," and many, as we can testify, know this truism only too well.

We are glad to receive the new edition of Mr. Mee's "Heavens at a Glance." This handy little almanac—printed on one side of a card for observatory use—has been prepared for 1900 on the same lines as for 1899, and will be found a valuable and convenient guide to observers. The data for meteoric showers have been taken from Mr. Denning's list in "Observational Astronomy," for variable stars from information supplied by Sir Cuthbert Peek, Mr. J. E. Gore, and Mr. J. Grover, and the rest from the "Nautical Almanac."

Early in the new year Mr. John C. Nimmo will publish the first volume by Prof. Sayce, of Oxford of "The Semitic Series," a new series of handbooks, intended to present compactly and in popular form a knowledge of the more important facts in the history, religion, government, language, customs, etc., of the Babylonians, Assyrians and allied Semitic races of ancient history.

BOOKS RECEIVED.

Memory Training: Its Laws and their Application to Practical Life. By Christopher Louis Pelman. (70, Berners Street.)

Common Sense Health Reform. By T. Thatcher. (Simpkin.)

On the Utility of Knowledge-Making as a Means of Liberal Training. By Prof. J. G. Macgregor.

Teleography. By Thomas R. Dallmeyer, F.R.A.S. (Heinemann.) Illustrated. 15s. net.

The Christmas Bookseller, 1899. (Whitaker.) 1s.

The Advance of Knowledge. By W. Sedgwick. (Allen.) 6s.

The Boyhood of a Naturalist. By Fred Smith. (Blackie.) 3s. 6d.

Englishwoman's Year Book, 1900. (Black.) 2s. 6d. net.

Who's Who, 1900. (Black.) 3s. 6d. net.

Science and Faith. By Dr. Paul Topinard. Translated by Thomas J. McCormac. (Kegan Paul.) 6s. 6d. net.

A First Book in Organic Evolution. By D. Kerfoot Shute. (Kegan Paul.) 7s. 6d.

The "Mechanical World" Pocket Diary, 1900. (Emmott.) 6d.

Makers of Modern Prose. By W. J. Dawson. (Hodder and Stoughton.) 6s.

Co-ordinate Geometry—The Conic. By J. H. Grace, B.A., and F. Rosenberg, M.A. (Clive.) 4s. 6d.

Twelve Months' Notes on Birds in the South Hams District—(August, 1898–99). By E. A. Savage Elliot.

Letters of Faraday and Schoenbein, 1836–1862. Edited by Kahlbaum and Darbishire. (Williams and Norgate.) 13s. net.

The Mind of the Nation. By Marcus R. P. Dorman, M.D. (Kegan Paul.) 12s. net.

The Story of the Wanderings of Atoms. By M. M. Pattison Muir. (Newnes.) 1s.

Useful Arts and Handicrafts Series:—Picture Frames by Novel Methods. Dyes, Stains, and Inks. Decorated Woodwork and Wood Carving for Beginners. (Dawbarn & Ward.) Illustrated. Each, 6d. net.

Whitaker's Almanack, 1900. Whitaker's Peerage, 1900.

The Races of Man. By J. Deniker, Sc.D. (Paris.)

Contemporary Science Series. Walter Scott. Illustrated. 6s.

Optical Activity and Chemical Composition. By Dr. H. Landolt. Translated by John McCrae, PH.D. (Whitaker.) 4s. 6d.

Monthly Star Maps for 1900. By W. B. Blaikie. (Scottish Provident Institution.)

Social Chess. By James Mason. (Horace Cox.)

The Studio. December. 1s.

THE BLACK RAIN OF AUGUST 6, 1899.

By Major L. A. EDDIE, F.R.A.S.

ON August 11th, 1888, a heavy fall of black rain (an account of which I published in the "Grahamstown Journal," of August 28th, 1888) took place in Grahamstown and the surrounding districts, extending over an area of more than 360 square miles, when I advanced several theories in an endeavour to explain the cause of this curious phenomenon; but no microscopical examination of the water itself was made on that occasion. During the early part of the month of August, in many of the intervening years since this recorded fall, there have been similar downfalls of blackish rain, though less pronounced, which have been either observed by myself or reported to me by others.

The fall in August, 1888, was heralded by an almost incessant low rumbling thunder, and, in like manner, the fall of black rain on the early morning of Sunday, the 6th August, 1899, which I have now to record, was preceded by a continuous bombardment of muffled growling thunder varied by one great deafening peal. This storm followed after a [illegible] stiff south-easter. The storm accompanying it and the corresponding time of the year, to my recollection agreeing with that of August, 1888, induced me to inspect the water that had fallen, when I was not surprised to find the colour and appearance of the fluid to resemble that of the previous August, viz., to be of a sable tint as if mixed with ink. On putting by some of this dusky fluid in a white enamelled vessel, I soon observed that the liquid partially cleared, and a black sediment was deposited, consisting of particles of a size separately perceptible to the unaided vision, but on trying to seize these particles between the finger they crumbled to an extremely fine powder and were exceedingly soft to the touch, and not in any way gritty, as would be expected if of an inorganic mineral or metallic nature.

On submitting this black dust to examination under the microscope, and using a high power, it became apparent that microscopic organisms were present. The spores, of a dingy brown colour, were mainly elliptical in form, though some were circular and some of an irregular pentagonal figure; where not crushed apart they were lying in heaps, or swarm-spores in close contact like clusters of bramble berries; there was occasionally to be seen a piece of, as it were, filamentous mycelium, from which the clusters or groups of sessile spores had been probably detached; the marginal border of these cells was dark, while the centre position was fairly permeable to the transmitted light, and some few seemed to possess a tiny dark nucleus; their average size was about the 1/12,500 of an inch, though many were much smaller and some few larger. On examination as an opaque object they reflected a bright yellow light in contrast to the dark background, but were not at all affected by polarised light. It will be seen that in this plate many of the elliptical sporules are arranged in catinaries, with their small ends abutting in a line with their conjugate axes, while some of these elongated members appear, on minute inspection, to consist of two circular sporules in close contact with a more or less defined septum between the individual cells.

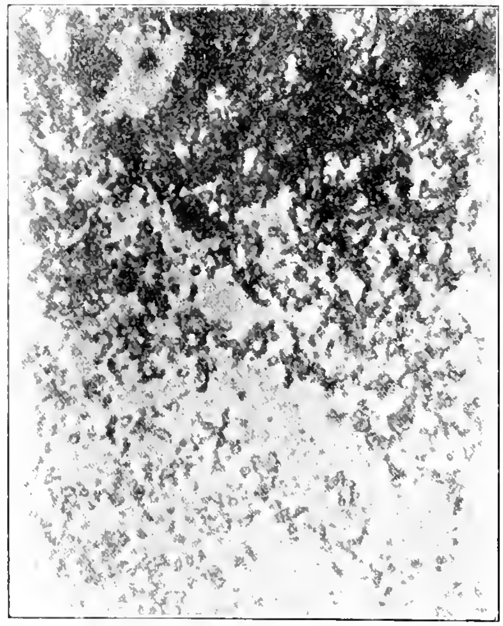
Again, many of these spores, more especially those of elongated form, appear to be germinating by emitting a thin filament, generally, though not in all cases, from one of the narrow ends; this filament is apparently in some instances holding two or more in conjugation, though when attached to a single cell it merely resembles a flagellum.

These aerial fungi may probably have belonged to the genus Rœstitia or Æcidium, both of which genera are known to exist in the Cape, producing in the earlier stage blight in the plants they infest, and subsequently smut, mildew, or rust in the wheat and barley.

The inky appearance of the water, both of August, 1888, and of August, 1899, soon cleared after it had stood for a time in the vessel into which it had drained, and but a comparatively small amount of sediment was deposited, much less indeed than might have been expected, judging from the very sable tint which the fluid wore upon its descent from the clouds. This black water was noticed after the rainfall of the 6th August, 1899, in all water receptacles throughout Grahamstown, but I have not heard of its being detected in the surrounding district.

Such rainfalls are not without precedent in other countries. Professor Barker, in April, 1849, reported to the Royal Dublin Society two observations on a shower of black rain that had fallen around Carlow and Kilkenny and extended over an area of some 400 square miles. It is described as being uniformly black at the time it fell, resembling ordinary writing ink, but that it soon cleared after standing, and a black sediment was deposited, and that the gardeners and shepherds had had their clothes blackened when working afterwards in the clover and the fields. No microscopic examination, however, seems to have been made.

Mary Somerville, in her classic work on Physical Geography, says—"Rain dust has been most wonderfully the means of proving that the trade winds, after meeting at the Equator, cross and continue their course as upper currents. Brick-red dust has frequently fallen in large quantities on ships in the Atlantic, especially about the Cape de Verd Islands, but specimens having been examined by Professor Ehrenberg from the Cape de Verd Islands, from Malta, Genoa, Lyons, and the Tyrol, he found that they all consisted of infusoria and organisms whose habitat is South America." "There is every reason to suppose that the dust collected by Mr. Rutland in 1839, nearly midway between the African and American continents, between the 10th and 14th degrees of north latitude, consisted of American infusoria," and the same authoress, writing of the ubiquitous infusoria, says that Professor Ehrenberg had



Elliptical Sporules (magnified) in black rain.

found them in fog, rain, and snow, and in the minute dust that sometimes falls on the ocean.

Mr. M. C. Cooke, in his work on Fungi, states that recent examinations of the common atmosphere prove the large quantity of spores that are continually suspended, and, generally, in considerable numbers. The majority of the cells were proved to be living and ready to undergo development. A suitable pabulum being exposed it was soon converted into a forest of fungoid vegetation. It has been held that the atmosphere is often highly charged with fungi spores. The experiments conducted in India have been convincing on this point ("Microscopic Examination of the Air," from the ninth Annual Report of the Sanitary Commissioners, Calcutta, 1872).

Many of these aerial fungi have been known to attack insects and use them as a basis for their parasitical growth; even the common housefly is a prey to a mouldy fungus called Sparendonema Muscae, as may be witnessed at certain seasons when our domestic companion is seen to take up his last resting place on our window panes surrounded with a white mouldy shroud.

That terrible pest, the locust, is also known to furnish a favourable medium for the cultivation of a fungoid vegetation, and valuable work is now being done in the Cape Colony by artificially sowing and disseminating the sporules of a suitable insecticidal fungus amongst these very destructible creatures, and thereby slaying countless myriads in a very brief space of time.

The Cape mycologic flora is said to be peculiar, and can scarcely be compared with any other. From the Cape and Natal collections have been made by Zeyher Drège and others. Humidity is known to contribute largely towards the copious production of fungi, and during protracted droughts the regions affected thereby will remain comparatively bare of fungi, but during seasons of frequent rainfalls the production of a fungoid vegetation is largely increased.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

THE ROBIN AND THE NIGHTINGALE.—In "Cries and Calls of Wild-Birds" I have compared a modified and very coarse rendering of the croak of the nightingale with the rattling alarm of the robin; and I instanced the croaking of two robins as illustrating a family resemblance between the cries of the two species. Another, and a remarkable, instance of this has recently been observed by me.

Early in August last I heard near my garden at Charlton Kings what I thought to be a nightingale giving its common cry, which may be written "whit-rrrr." But something in the tone of the cry attracted attention, and I was astonished to see what I felt positive was a robin, giving the notes. But I could not see the bird's breast, and therefore could not be quite sure of it. The bird soon flew away, in the manner of a robin, and was seen no more. But early in November I saw and heard in the hedge about a quarter-mile below the railway station, a robin giving the "rrrr" croak of the nightingale exactly, sometimes preceding it with one or more of the ticking sounds heard in the robin's rattling alarm. Mostly one tick only was given. Anyone, even a good observer, hearing the croak only, would at once have said that it was uttered by a nightingale. The robin is of course a near relative of the warblers, and its use of one of their most typical alarm-cries is worth recording.—CHARLES A. WITCHELL, Charlton Kings, Cheltenham.

An Observational Diary of the Habits of Nightjars (Caprimulgus Europaeus), mostly of a Sitting Pair. Notes taken at time and on Spot. By Edmund Selous. (*Zoologist*, September, 1899, pp. 388-408; November, 1899, pp. 486-505.) The very full title of this article explains its object. Mr. Selous has evidently taken a vast amount of pains in watching and recording most minutely the doings and "sayings" of this pair of Nightjars from the time the eggs were laid until the chicks hatched. To those who wish to be familiar with the domestic arrangements of the Nightjar we recommend a perusal of Mr. Selous' most original series of interviews.

Recent Observations on [illegible] Dublin Coast. By Charles J. Patten. (*Irish Naturalist*, December, 1899, pp. 253-256.) These interesting notes chiefly relate to the occurrence of various species of waders—some of them irregular visitors to Ireland.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

Bell covers, for protecting preparations from dust, may be made by cementing a small handle or cork to the centre of the convex side of watch glasses.

Mr. H. F. Moore, of the United States Fish Commission, has recently published the results of his investigations on the food of herrings. The staple diet of these fish consist of minute organisms, often of microscopic dimensions. Examinations of the stomachs of the fish showed the food to consist largely of copepods, schizopods (shrimp-like forms), amphipods (sand fleas and their allies), the embryos of gasteropods and lamellibranchs, and young fishes, often of their own kind. Many of these possess phosphorent spots, due to the presence of photo bacteria, which enable the herring to follow their prey by night. Mr. Moore has often watched the herrings at night swimming backwards and forwards in search of their prey, "apparently screening the water, their every movement traced by a phosporescent gleam evoked perhaps by the very organisms which they are consuming."

The necessity for exercising great caution in the use of pork as food is again brought home very forcibly to us in the last report of the microscopist of the Department of Agriculture, U.S.A. In the microscopal inspection for trichinæ, 1,881,309 specimens were examined, and of these 13,325 were found to be infected. The expenses connected with this examination cost the Government 11,669 dollars.

Salicylic acid crystallized from alcohol gives, when mounted, a beautiful combination of gold and green, with shades of purple and silver points. The method of mounting is as follows:—Dissolve the acid in alcohol and allow a drop of the solution to fall on the slide. Apply heat for a few seconds, and when cool, ring the preparation with balsam and allow it to set. It may be necessary to super-impose several rings of balsam, but in each case the lower ring should have thoroughly set before another is applied. Slightly warm a cover glass and place it on the ring. The cell may then be sealed with asphaltum and finished according to taste. The preparation is most effective as a "show" slide.

In the same paper, Mr. MacDougall discusses the question of the action of the bacteria of leguminosæ, and describes the experiments of Prof. Nobbe and Dr. Hilltner in inducing nodule formation in plants by inoculation with pure cultures. To make pure cultures a fresh nodule is washed carefully, and after being dried in blotting paper, it is dropped for a moment into corrosive sublimate to kill any bacteria on the surface. It is next washed in absolute alcohol, and cut with a scalpel that has been sterilized in a flame. A platinum needle is dipped into the cut, and gelatine, previously prepared with a decoction of leguminous shoots, is streaked with it. The bacillus radicicola, being an aerobic form, requires a large surface of gelatine for propagation. A pure culture is obtained in a few days. To inocculate plants with the microbe, the bacilli are transferred to water, and a little of the mixture is sprinkled over the soil in which the plants are growing.

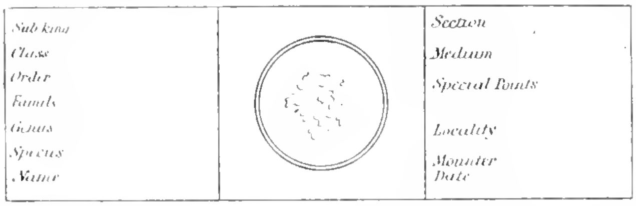
Living diatoms survive for days when stained with methyline blue solution (one in one hundred thousand), but the vitality of the cells wane from the moment the nucleus takes up the stain.

When photographing bacteria and other minute organisms, the cone of light should never be reduced by stopping down. Without a full sized cone of light, diffraction lines will appear around the organism.

The use of mercury pellets is recommended to free slide boxes and store cabinets from mites, psoci, etc., and also to collect any particles of dust which may gain entrance. A few small pellets of mercury, placed free in the bottom, will, by the movement of the box or cabinet, be caused to roll to and fro and accomplish the desired end.

In the course of some petrological investigations on the north shore of Lake Superior, Mr. A. P. Coleman discovered a new mineral, at Heron Bay, Lake Superior, which he has named *Heronite*, and which he describes at length in the *Journal of Geology*. It is a dike rock, consisting essentially of analcite, orthoclase, plagioclase, and ægyrite, the analcite having the character of a base in which the other minerals form radiating groups of crystals. The analcite clearly represents the magma left after the crystallization of the embedded minerals, and it is evident that it can be formed only from a magma highly charged with water, and therefore under pressure.

The labelling of microscopic objects, when done properly, forms a no unimportant part of the training of a microscopist. Apart from the discipline that it affords in habits of painstaking research, the systematic record that a label contains is a great time saver to the student, inasmuch as, when it is necessary to refer to the object again or to compare it with a series of objects belonging to the same genus, he is enabled to see at a glance the relation that each object bears to the others in the system of classification that is adopted, thus rendering further references to text and note books unnecessary. For these reasons the following example has much to recommend it. The labels



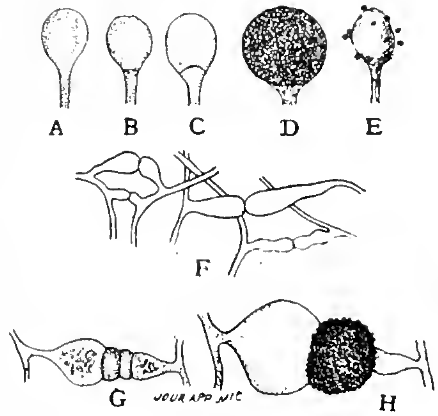
should be printed in sheets and details filled in before the labels are trimmed to size. They are placed on the slide, one on either side of the object.

Minute soft-bodied insects do not lend themselves to methods of preparation that will enable them to be kept in a condition serviceable for subsequent scientific study. Alcohol deprives them of their colour, and balsam frequently distorts, and so destroys the characteristics of venation and of jointed appendages. The method of roasting by the sudden application of intense heat has hitherto proved itself to be one of the best means of dry preservation. For Aphides the following procedure gives satisfactory results. The *living* Aphis is put on a sheet of white paper, and at the moment when it is in the desired position the paper is held over a flame, and in an instant it will be dead and will retain the attitude. Then put it, still on the paper, into an oven; or, still better, hold it over the heated tin, carefully watching the drying and moving the paper about in order to prevent it getting singed. The roasting is quickly accomplished in either way. If the paper burns brown it is a sign that caution is requisite. To pierce these brittle preparations is hazardous, and it is a better way to mount them with gum in a dry cell.

The question of the limit of resolving power of objectives is discussed by Dr. L. B. Twitchell, who points out that up to the present, Nobert's twentieth band, 225,190 lines to an inch, has never been resolved, and, theoretically, with white light only 146,543 lines per inch can be distinguished. By utilizing, however, the shorter actinic rays and a photographic plate, theoretically 193,037 lines per inch should be resolved—that is, effects beyond the possibility of ocular vision.

Mr. G. E. Stone descants, in the current issue of the *Journal of Applied Microscopy*, on the advantages of formalin as a preservative for botanical specimens. He has used formalin in his laboratory for six years for the display of the morphological, physiological, pathological and ecological characteristics of plants with most satisfactory results. The strength of the formalin solution used for preserving specimens is four parts of the forty per cent. solution to one hundred parts of water. Two to three parts to one hundred have been tried, but solutions of this strength have not proved satisfactory. Most of the specimens have been kept in a 4-100 parts solution for five years without renewing, and with the exception of a slight tendency to form a precipitate in some of the jars, they are as clear as ever. Formalin solution gives clear white colourless tissues, whereas the tissues placed in alcohol have invariably turned to a dirty brown.

In the same Journal, Prof. C. J. Chamberlain continues his admirable series of articles on methods in plant histology. He treats of the Algæ, freshwater and marine, and of the Fungi Under the Phycomycetes, he briefly discusses Mucor stolonifer, the familiar bread mould, and suggests the following method as a sure and rapid method for obtaining it:—Place a glass tumbler in a plate of water, put a slice of bread on the tumbler, and cover with a glass jar. To obtain such a series as is shown on the A-D of the figure, the material should be studied before the sporangia begin to turn black. The phase in the life-history indicated in F H is rarely seen, and therefore the writer would be glad to hear from anyone who has met this phase, especially if the information could be accompanied by a few dry zygospores. A very satisfactory study may be made from the living material. Corrosive sublimate (four per cent.) in fifty per cent. alcohol. used hot, is recommended as a fixing agent.



A-D.—Successive stages in the development of the sporangium. E. Columella with a few spores adhering. F-H.—Stages in the formation of the zygospore.

NOTES ON COMETS AND METEORS.

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

COMETS.—At present there is very little of general interest to observers as regards visible comets. Several of these objects may possibly be picked up in very large telescopes, but they have passed beyond the capacity of ordinary instruments.

The year 1899 has not been very productive of cometary discoveries, for only two new comets have been announced These were by Lewis Swift on March 3rd, and by Giacobini on September 29th. Apart from these, returns of three periodical comets have been observed, viz., that of Holmes's comet (detected by Perrine on June 10th, perihelion passage April 28th), Tuttle's comet (detected by Wolf at Heidelberg, March 5th, perihelion passage May 14th), and Tempel's comet, 1873 II. (detected by Perrine, May 6th, perihelion passage September 28th). The first periodical comet due in 1900 will be Finlay's (seen in 1886 and 1893), which should be in perihelion early in the spring, but the conditions will be unfavourable, and the comet may escape observation at this return. In the autumn of 1906 this comet should be well seen, as it will be comparatively near the earth.

HOLMES'S COMET.—Mr. R. G. Aitken, in describing (*Ast. Nach.* 3602) six observations which he obtained of this object in August and September with the 36-inch equatorial of the Lick Observatory, says "The comet was very faint—not as bright as a 14th magnitude star when best seen—and on the night of September 2nd, when the seeing was very poor, it was at times entirely invisible. It showed only feeble condensation, and the outlines were very vague."

THE SHOWER OF LEONIDS IN 1899.—A large number of observers have reported observations, but the experience in England and foreign places seems to have been general that the phenomenon presented a very feeble aspect. Occasional meteors shot from the sickle of Leo, and demonstrated that the earth was either passing near or through the swarm, but the brilliant spectacle which it was hoped would have been visible was nowhere realized. Many people who do not even make a hobby of astronomy remained up all night watching from their windows or from commanding positions whence the display might have been viewed to the best advantage, but disappointment was almost universal. At some stations, however, it is gratifying to find it reported that meteors were tolerably numerous, and that a few fine Leonids were noticed. From these a proportion of the impromptu observers received at least a small measure of satisfaction. It may be a solace to those who saw little or nothing, when they reflect that the shower may be brilliantly visible in 1900 or 1901. In several newspapers the statement has lately been made that all chance of seeing the meteors has gone until a generation hence, when the swarm, having completed another revolution, would return in 1933. This is, however, based on a misconception, for the denser portion of the system occupies several years in passing through that region of the orbit intersected by the earth at the middle of November. We are fairly entitled to expect that either in November 1900, or 1901, the shower will be witnessed at its best, though it seems probable that in the former year it will occur during daylight in England, and 1901, when there will be no moon, apparently offers much the best prospect.

The Meteors of Biela's Comet.—There was reason to expect that as nothing of these meteors was noticed in 1898, and as the parent comet, if it still exists, passed through its perihelion some time this year, that a pretty strong shower of them might be seen on about November 23rd or 24th. They were accordingly looked for at several places, and with moderate success, for a very definite shower of Andromedids was observed. At New York, Prof. Young, at the Princeton Observatory, saw forty-two meteors on November 24th belonging to this shower, and secured photographs of several. The astronomers of the observatory at Vienna watched between early evening and moonrise on November 23rd, and counted sixty-seven shooting stars, mostly directed from the constellation Andromeda. A magnificent fireball was also seen shining in that constellation. Twelve photographs were secured. Mr. E. C. Willis reports in *Nature* of December 7th, that on November 24th he watched from 10 to 11.25, and noted fifty-two Andromedids and ten other meteors. The shower was strongest between 10 and 10.15, when twenty Andromedids were seen. At Bristol the same ill-fortune followed the observers as on November 14th and 15th, for clouds veiled the heavens on November 23rd and 24th, except for about half an hour in the early evening of November 23rd, when in a beautiful sky only two meteors were seen, and neither of these were Andromedids. It is probable that on the afternoon or early evening of November 24th the shower formed a pretty, bright, and numerous one, but we have not yet received any reports which would lead us to think that the display was in any way comparable to the imposing showers of November 27th, 1872, and 1885. The next really rich display of these meteors will probably occur on November 18th, 1905. In the spring of 1901, Jupiter will be in the region of this meteor group, and disturb it in a manner to bring its apparition six days earlier than at the present time according to the computations of Schulhof and Abelmann.

The Quadrantids.—This annual shower is sometimes rather striking, and quite as rich as the Perseids, though it has been comparatively seldom observed. It should be looked for on the early evening of January 2nd, and morning of January 3rd. The radiant is at 230° + 53°; the meteors are pretty bright, of moderate velocity, and traverse long paths.

THE FACE OF THE SKY FOR JANUARY.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 8.8 and sets at 4.0; on the 31st he rises at 7.42 and sets at 4.46. The sun is at its least distance from the earth at 6 a.m. on the 2nd, the apparent diameter then being at its maximum, 32′ 35″.08; the horizontal parallax is then 9″.00. Few sun-spots are to be expected.

The Moon.—The moon will be new on the 1st at 1.52 P.M., will enter first quarter on the 8th at 5.40 A.M., will be full on the 15th at 7.8 P.M., will enter last quarter on the 23rd at 11.53 P.M., and will be again new on the 31st at 1.27 A.M. The following are the most conveniently observable occultations during the month:—

Date.	Name.	Magnitude.	Disappearance. Time.	Angle from N.	Angle from V.	Reappearance. Time.	Angle from N.	Angle from V.
Jan. 6	19 Piscium	5·2	7.12 P.M.	91°	63°	8.10 P.M.	[illegible]	182°
,, 10	ϵ^1 Arietis	5·2	7.1 P.M.	33	49	7.59 P.M.	295	296
,, 10	65 Arietis	5·6	7.55 P.M.	15	47	9.1 P.M.	288	271
,, 11	κ Tauri	4·6	10.27 P.M.	115	90	11.31 P.M.	231	205
,, 11	κ Tauri	5·5	10.40 P.M.	143	115	11.23 P.M.	213	178

The Planets.—Mercury is a morning star throughout the month, but is not well placed for observation in our latitudes on account of his great southerly declination.

Venus is an evening star, setting on the 1st about 2 hours after the sun, and on the 31st nearly 3 hours after the sun. The planet will be found low down, south of west, soon after sunset. At the middle of the month nearly nine-tenths of the disc will be illuminated.

Mars will be in conjunction with the sun on the 16th, and cannot be observed this month.

Jupiter is a morning star, rising shortly after 4 A.M., at the middle of the month, his polar diameter then being 30″.6. The movement of the planet is direct, in the northern part of Scorpio.

Saturn is a morning star but too near the sun for easy observation, rising just before half-past six at the middle of the month.

Uranus is also a morning star, rising about 5 A.M. at the middle of the month.

Neptune, in Taurus, may be seen almost all night. His movement is westerly. He is in the Milky Way, almost midway between Zeta Tauri and 132 Tauri.

The Stars.—About 9 P.M. at the middle of the month, Ursa Major will be in the north-east, Leo and Cancer towards the east, Gemini high up, and Canis Minor lower in the south-east, Auriga and Perseus nearly overhead, Orion and Taurus nearly in the south, Aries and Cetus towards the south-west, Pegasus and Andromeda in the west, and Cygnus in the north-west.

Convenient minima of Algol will occur on the 4th at 7.33 P.M., on the 24th at 9.15 P.M., and on the 27th at 6.4 P.M.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of December Problems.
(C. D. Locock.)

No. 1.

1. Kt to K7, and mates next move.

No. 2.

1. B to Kt2, and mates next move.

Correct Solutions of both problems received from E. A. Servante, H. S. Brandreth, W. de P. Crousaz, W. d'A. Barnard, G. F. Todd, J. Baddeley, A. E. Whitehouse, G. C. (Teddington), K. W., H. Le Jeune.

Of No. 2 only, from Alpha, G. A. Forde (capt.).

J. T. Blakemore.—Many thanks for your prompt response; the two problems appear below.

J. NEVILLE.—Very glad to receive your appreciative letter.

G. F. TODD.—Your suggested key 1. Kt to Kt5 to the four-mover certainly comes very near. For instance neither 1. . . . P × P nor 1. . . . B to Kt5 nor 1. . . . K to Q4 are valid defences. There is nothing left therefore except 1. . . . B × Kt.

J. O. NEUMANN.—In No. 1, after 1. B to KKt7 there is no mate, whatever Black reply. In No. 2, 1. B to K7 is answered by K to K4 or Bishop moves. By exchanging the column of letters for the row of figures your notation would become the ordinary German notation.

ALPHA, G. A. FORDE.—If 1. Kt to KR4, P to Q4. Hence the Black Pawn at KKt5.

B. G. LAWS.—Problem withdrawn as requested. The coincidence which prevents its publication is as curious as it is unfortunate for us.

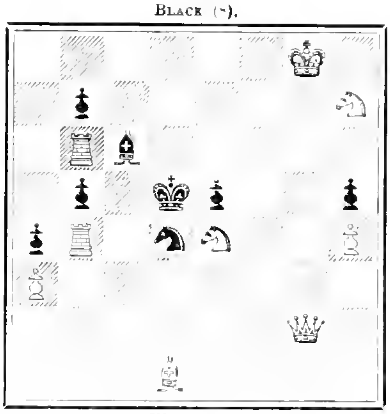
J. BADDELEY.—We quite agree with you in principle: but how about a fifteen-move problem? Few players but Mr. Blackburne could manage this from the diagram alone: and yet these long problems, sui-mate or otherwise, frequently contain the most beautiful combinations. Moreover, if the composer moves the pieces, may not a mere solver do likewise without reproach?

PROBLEMS.

By J. T. Blakemore.

No. 1.

BLACK (7).

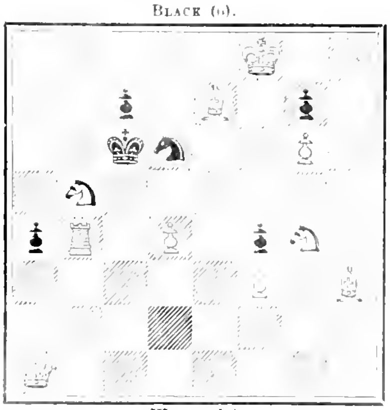


WHITE (9).

White mates in two moves.

No. 2.

BLACK (6).



WHITE (10).

White mates in two moves.

Mr. Blackburne's Games at Chess. Edited by P. Anderson Graham. (Longmans, Green & Co.)

Some two or three years ago Dr. Tarrasch published a selection of 300 of his games. Mr. Blackburne has now followed suit with this handsomely bound volume, which contains more than 400 of his games, selected, annotated and arranged by himself. Mr. Blackburne has undoubtedly been, for the last thirty years, the most prominent of English chess-players: the present volume illustrates his skill in all departments of the game. The games are divided into four sections, viz.:—

(1) Match, Tournament, and Consultation Games. In this section the games are grouped under the various openings, the arrangement in other respects being chronological.

(2) Games played off-hand, simultaneously, or at odds.

(3) Endings from Actual Play.

(4) Games played Blindfold. This last section is prefaced by a short history of blindfold chess contributed by the Editor, who is also responsible for the interesting biography of Mr. Blackburne at the beginning of the book. The annotations to the games are brief and descriptive rather than analytical. Since the editorial days of Zukertort and Steinitz the analytical method of annotation has gone out of fashion. Mr. Blackburne prefaces each opening with a brief resume of its characteristic features. We may perhaps take exception to his description of the Ruy Lopez as a dull opening "leading to no attack." This seems a little hard on the favourite opening of Mackenzie and Zukertort, to say nothing of Morphy and Anderssen. Twenty-eight of Mr. Blackburne's excellent problems in three and four moves conclude the volume, which is published at 7s. 6d. net. It should certainly have a large sale.

CHESS INTELLIGENCE.

The Anglo-American cable match will take place during March. The British team will undergo some alterations. Mr. Locock has retired from active chess. Mr. Lawrence has been singularly unfortunate on both the occasions on which he has represented his country; but as he has already scored six successive victories in the City of London Championship tourney, and has therefore again the best chance of winning that competition, he could hardly be left out of any representative team. Messrs. W. Ward, R. Loman, and Jacobs are also making good scores.

For Contents of the Two last Numbers of "Knowledge," see Advertisement pages.

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WIRELESS TELEGRAPHY.

By G. W. de Tunzelmann, B.Sc.

In the ordinary commercial system of telegraphy, signals are transmitted between two distant stations by means of electric currents made to flow through a circuit consisting of an insulated wire connecting the two stations and the earth. The wire being connected with the earth, or "earthed," as the telegraphist expresses it, at each of the stations in order to make a complete circuit or loop round which the electric flow takes place.

When a new system of sending electric signals in which no connecting wire was required between the two stations came into prominence it was named from the most striking features to the ordinary observer, namely the absence of the connecting wire.

The name is not logically defensible, for on the one hand the method of signalling known as "Wireless Telegraphy" involves the use of wires both in the transmitting and in the receiving apparatus, and on the other hand it includes systems of signalling which are not popularly supposed to be electrical at all.

The term ætheric telegraphy which has also been suggested, is just as open to the latter objection as the one in common use, and personally I should be inclined to suggest the term Hertz Wave Telegraphy or Hertzian Telegraphy, for the system of telegraphing without connecting wires which is now exciting so much interest and attention. Though greatly developed by the researches of Lodge, Marconi, and others, Hertzian telegraphy depends entirely upon exciting at the transmitting station and detecting at a distant receiving station æther waves of a certain character, the existence of which had been deduced theoretically by Professor Clerk Maxwell, but first experimentally demonstrated by the late Dr. Hertz, of Carlsruhe, who published the results in a series of papers in "Wiedemann's Annalen" beginning in July, 1887.

It has long been an admitted fact that the observed phenomena of light can only be explained by the existence of a highly elastic medium, to which the name of luminiferous æther has been given, and which must fill at any rate the whole of the space into which our vision can penetrate, that is to say the space intervening between the earth and the most distant visible stars.

The phenomena of light show, that for extremely rapid motions such as light waves, which traverse some 186,000 miles in a second, this medium is far more rigid than steel, while for comparatively slow motions such as those of the planets (the earth's speed in its journey round the sun is considerably under 20 miles a second), it offers so little resistance that in most cases it is imperceptible to us. In the case of Encke's comet astronomers believe they can just detect evidence of the existence of a resisting medium in space, but that is all.

If any reader is disposed to object to the assumption of a medium behaving in such very different ways with regard to motions of different speeds, it may assist in convincing him that the objection is not a valid one, to direct his attention to the similar behaviour of such a familiar substance as pitch. In moderately cold weather this material has all the appearance of a solid, and will resist a blow or momentary heavy pressure. If, however, a denser body than the pitch, such as a bullet for example, be laid upon its surface, it will gradually sink until it rests upon whatever is supporting the pitch. If on the other hand the pitch is placed upon a less dense body, such as cork, the latter will float up through it in the course of time. The pitch, therefore, exposes great resistance to rapid motion, but the smallest pressure causes it to give way if sufficient time is given, or, in other words, when the motion slows down sufficiently the resistance becomes negligeable, thus offering very close analogy to the behaviour of the luminiferous æther.

When a disturbance is set up in a medium, waves are in general emitted in all directions from the point of disturbance. Sound we know is transmitted by air, and, unlike light, it will not traverse what we call empty space, viz:—space occupied only by æther.

Now, air and other gases are composed of molecules in an irregular condition of agitation which can be shown to explain the observed fact that sound is transmitted through air entirely by longitudinal vibrations, that is to say, by waves in which the portions of the vibrating medium move backwards and forwards in a direction parallel to that in which the wave is travelling. Vibrations in other directions are necessarily started by the disturbance which gives rise to the sound, but it is found that the transverse vibrations die away almost immediately. Clerk Maxwell points out that, within a single wave length, the amplitude of the transverse vibrations will be reduced to less than one-five-hundredth of its initial value owing to this state of irregular agitation.

In the case of light, on the other hand, it is found that transverse vibrations are the only ones which are transmitted, that is to say, that all vibrations along the line in which the wave is travelling die away almost immediately, so that the vibrations are entirely perpendicular to the line of transmission. The reason of this had never been explained until Maxwell showed, from electromagnetic theory, that electric waves must have this characteristic. This suggested to him the hypothesis, that light waves were simply electric waves, of such wave lengths as to be capable of affecting the receiving instrument commonly known as the eye.

Many phenomena when investigated were found to confirm this hypothesis; the close correspondence, for example, between the calculated speed of transmission of an electromagnetic wave and the observed velocity of light; and, again, the fact that transparent substances are invariably bad conductors of electricity. Hertz, however, made a step further, for, as we shall see, he succeeded in producing waves known to be of electro-magnetic origin, and in showing that they could be made to produce interference phenomena and undergo reflection and refraction exactly like light waves.

When oscillations are set up in an electric circuit it can be shown that the time, T, of a complete oscillation is determined by the equation

$$T = 2\pi \sqrt{L, S},$$

where L and S are two of the electric constants of the circuit known as its self induction and its capacity respectively, while of course π stands as usual for the ratio of the circumference of a circle to its diameter, which is approximately equal to 22/7.

The speed with which the waves travel, depends only on the medium being equal to the square root of the ratio of its elasticity to its density. In the case of the æther this speed is about 186,000 miles a second, the observed speed of light.

We will now consider the question as to what kind of æther waves are most suitable for the transmission of signals to a distance.

The conditions to be fulfilled are clearly two in number. Firstly, in order that the waves may not be stopped by intervening obstacles, such as portions of land and water, we require oscillations for which the opacity of different kinds of matter is least, or, in other words, those oscillations for which ordinary terrestrial bodies are most transparent.

Secondly, in order that the signals may be distinguishable at as great distances as possible with a moderate expenditure of energy, we require those oscillations for which the largest possible proportion of the energy supplied from the source, the transmitting instrument may be taken up by the medium.

We know that ordinary light waves, the wave lengths of which are measured in hundred-thousandths of an inch, fulfil the second condition in the most satisfactory manner, but unfortunately they do not fulfil the first, for the thinnest films of most substances are sufficient to stop them. Still, they were employed for the earliest attempts at wireless telegraphy, which is far more ancient than the system of telegraphing by means of wires. In the earliest examples of which we have any record, the requisite æthereal oscillations were excited by means of large bonfires, and the difficulty of fulfilling the second condition was evaded by placing both the transmitting instrument consisting of the bonfire, and the receiving instrument, which was simply the eye of the watchman, on the highest hills available, so that the waves excited had only to encounter the comparatively transparent atmosphere. The semaphore of a hundred years ago and the heliograph of to-day offer further examples of wireless telegraphy by means of electric oscillations of extremely short wave length.

All bodies become less opaque to electric bodies as the wave length increases. The reason of this, according to theory, is that the quenching of the waves does not take place immediately on entering any opaque medium, as would be the case if it were a perfect conductor of electricity, but the waves die out after a certain number of vibrations depending on the opacity of the medium.

It is clear, therefore, that in the case of a medium which will permit of half-a-dozen vibrations before the wave is quenched, a very thin film will suffice to stop light waves which are of the order of a hundred-thousandth of an inch in length, while a much thicker stratum would be required to stop the Hertzian waves which may be from a foot to some few yards in length, while no practicable thickness would stop the waves from an alternating dynamo, say with a periodicity of 100 vibrations a second, as in this case the wave length would be something like a couple of thousand miles.

Unfortunately, as the wave length increases, the second condition is less and less perfectly fulfilled.

The reason for this is extremely interesting. Sir George Gabriel Stokes, so long ago as 1849, showed by mathematical reasoning from observed optical phenomena, that when a wave of light is excited from a given source, the radiation is emitted, not from the source itself, but from a point a quarter wave length in advance of it. This very curious phenomenon is completely explained when light waves are admitted to be of electromagnetic origin.

When an electric disturbance is set up at a certain point, it is always accompanied by a magnetic disturbance in a plane at right angles to it. The electric disturbance occurs a quarter of a period later than the magnetic, but it starts a quarter of a wave length in advance, so that, except within the first quarter wave length, the two travel together, their zero and maximum values always occurring at the same points.

Within the first quarter wave length, however, the two disturbances sometimes reinforce and sometimes oppose each other, and the result of this, as Professor Poynting has shown, is that, within the first quarter wave length, the energy originally proceeding from the source of the disturbance is sometimes travelling forward and sometimes backward towards the source, so that, although more goes forward than comes backward, a large proportion is wasted.

Beyond the first quarter wave length, however, the two disturbances tend always to cause an outward flow of energy.

It is, therefore, easily seen that in the case of a wave a hundred-thousandth of an inch in length, the point from which the radiation begins being only the four-hundred-thousandth of an inch from the source, there will be very little energy returning to the source.

On the other hand, in the case of a dynamo such as referred to above, with a wave length of some 2,000 miles, the emission point would be some 500 miles from the source, so that very little of the energy of the source would reach this point, by far the larger proportion being returned to the source.

We see, then, that the two conditions to be fulfilled are diametrically opposed to each other, and it becomes a matter for experimental investigation to determine what kind of wave lengths are most advantageous for telegraph work under varying conditions as to distance and other circumstances.

The preceding brief outline of the principles underlying the Hertz wave method of wireless telegraphy, will enable the reader to follow the descriptions of experimental work and practical details with greater facility, and, I trust, also with greater interest, by reason of his having obtained a general view of the fascinating country through which I am to have the privilege of acting as his guide.

Before proceeding to this exploration, however, I will ask him to linger with me for a moment to take a passing glance at two other methods, which are as yet in the infantile stage, but one or both of which may not impossibly in time outgrow their elder brother.

These are, the system of conduction through the sea or moist earth, and the system of electromagnetic induction.

In the earliest attempts at electric telegraphy, a complete metallic circuit was employed, requiring a pair of wires to connect any two stations.

In the year 1838, Steinheil tried unsuccessfully to utilise the two lines of rails of a railway in place of overhead telegraph wires, but, as has so often happened, his investigations into the cause of his failure led him to a most important discovery.

He found the reason to be that the earth was so good a conductor, that the electric current from the transmitting station, instead of flowing along one of the rails to the distant station and returning by the other, as he had anticipated, simply flowed across to the other rail through the earth on which they rested, and this at once suggested to him that it should only be necessary to have one wire between the two stations, provided this wire was earth-connected at each station, and this he found to be the case.

He also suggested that, the earth being so good a conductor, it might be possible to do away with connecting wires altogether, but I am not aware of his having devised any means by which this could be done.

Four years later the American, Professor Morse, who took so large a share in the development of electric telegraphy, succeeded in transmitting messages across a canal, 80 feet in width, and afterwards across the Susquehanna River, a distance of nearly a mile, by the

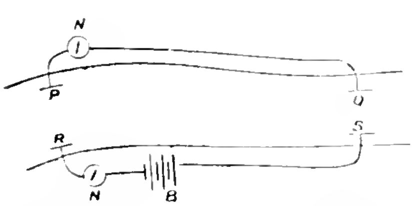

FIG. 1.—Morse's method of transmitting messages across the Susquehanna River.

method shown in Fig. 1, where B is a battery, N N a pair of needle instruments for transmitting and receiving signals, and P Q R S are metallic plates immersed being connected with insulated wire.

He obtained very good results when the distances from P to Q and R to S were three times as great as those from P to R and from Q to S.

In this connection I cannot refrain from pausing for a moment to refer to J. B. Lindsay, of Dundee, a Scotch schoolmaster of the very slenderest means, who made several important electrical discoveries, though unfortunately very little was heard of them except by his immediate neighbours, until they were unearthed some few years ago, when they were only of historical interest. He carried out a long series of experiments similar to those of Morse, quite independently but a year later.

After this, the subject appears to have excited very little attention, until in the year 1880, Professor John Trowbridge, of Harvard College, discovered that all the neighbouring telephone circuits were affected by the time signals sent from Harvard to Boston, some four miles away. He investigated the cause of these disturbances, and found that they were not due to induction, but to earth currents produced by leakage from the clock circuit.

Trowbridge saw at once that this might be utilised for the purpose of sending telegraphic messages without connecting wires, and he proposed attempting to telegraph across the Atlantic by sending alternating currents from a large dynamo through an insulated cable extending from Nova Scotia to Florida and earthed at each end, and placing another long wire with a telephone in its circuit down the coast of France.

He proposed signalling to ships at sea by means of similar means, and also by means of magnetic induction between coils carrying interrupted currents and using a telephone as detector, but he found that it would be necessary to employ either coils, far too large for use on board ship, or extremely heavy currents.

During the following year Graham Bell, the inventor of the telephone, began some interesting experiments of which I will only describe one, which he carried out on the Potomac River.

A battery and an interruptor were placed in a boat and connected by a wire about 100 feet long, one end of which was soldered to a metallic plate immersed in the water near the bow, while the other end was attached to a similar plate, which was buoyed by a float and allowed to trail astern. Bell himself was in another boat similarly equipped, except that the battery and interruptor were replaced by a telephone, and he found that he could clearly distinguish the signals at a distance of a mile and a quarter from the first boat. He strongly urged that a similar method should be employed for communicating between steamships, the steamer's electric lighting dynamo being used to replace the battery.

In 1882, Mr. W. H. Preece, now Sir William Preece, began to turn his attention to the subject with a view to effecting communication with lighthouses and lightships, where continual interruptions occur owing to the cables being broken or damaged by the heavy seas.

One of his earlier experiments was to establish a telegraphic circuit between Southampton and Newport in the Isle of Wight.

As shown in Fig. 2, one wire was carried from Portsmouth through Southampton to Hurst Castle, the two ends being connected to large metallic plates immersed in the sea at Southsea Pier and Hurst Castle respectively. Another overhead wire was carried from

Ryde through Newport to Sconce Point, and the ends connected as before to metallic plates immersed in the sea.

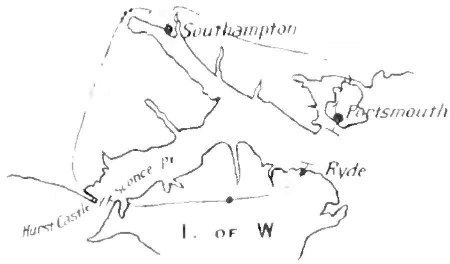

Fig. 2.—Preece's method of transmission between Southampton and Newport.

With 30 Leclanche cells and a buzzer and Morse key at Southampton, the signals were found to be perfectly audible at Newport in a telephone on the circuit.

Three years later Mr. Preece arranged some interesting experiments on wireless telegraphy by electromagnetic induction in the neighbourhood of Newcastle, which were carried out by Mr. A. W. Heaviside. Two squares of wire, each side a quarter of a mile in length, were placed at distances a quarter of a mile to 1,000 yards apart. In the former case the signals could be easily read by a telephone in the receiving circuit, and audible sounds were produced even at the greater distance.

Further experiments were made with parallel lines of telegraph, ten and a quarter miles apart, between Durham and Darlington, and it was found that the ordinary working currents in one line produced distinctly audible sounds in a telephone in the other. Equally successful experiments were made between parallel lines of telegraph on the East and West Coasts about forty miles apart, but in these experiments there arose the question whether the effects might not be due in part to leakage from the network of telegraph wires covering the intervening country.

The first practical application of the results of these experiments was to establish communication between Lavernock Point near Cardiff and two islands, Flat Holm at a distance of about three and a third miles, and Steep Holm at a distance of rather more than five and a third miles. (See Fig. 3.)

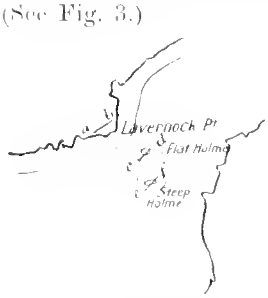

Fig. 3.—Preece's method of transmission between Lavernock Point and the Islands Steep Holme and Flat Holme.

On the shore a copper wire 1,267 yards in length was suspended on poles and earthed at each end. In this circuit was an alternating dynamo capable of giving a current up to 15 amperes, and a Morse key for breaking up the alternations into signals. At a distance of 600 yards from this circuit, on the sand at low water mark, a secondary circuit, composed of two gutta percha covered and one bare copper wires, were laid down and their ends buried in the ground. On the two islands, gutta percha covered wires, each 600 yards long, and parallel to those on shore, were laid down. The signals in the telephone on Steep Holm were audible, but not sufficiently distinct to be read, but messages were easily read off in the telephone on Flat Holm.

I will conclude this article by a brief reference to a method devised and patented by Mr. Willoughby Smith, and a modification patented by him in conjunction with Mr. W. P. Granville.

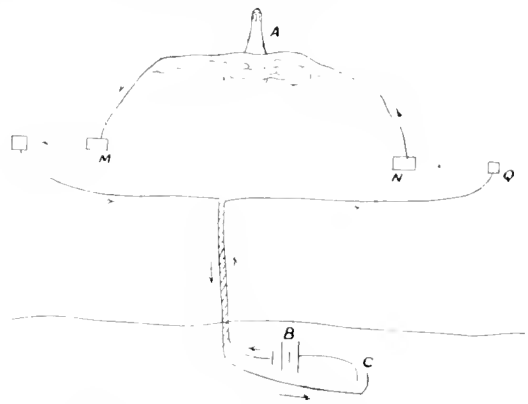

Fig. 4.—Willoughby Smith's method of communication between a lighthouse and the shore.

In Fig. 4 a lighthouse is shown at A, and insulated wires lead from the terminals of a telephone in the lighthouse to metallic plates, M N, submerged on opposite sides of the rock. Two other plates, P and Q, submerged to a sufficient depth to be unaffected by waves, are connected by an insulated cable, having in circuit with it a battery, B, and an interruptor, C. The course of the current is shown by the arrows. The modification of Mr. Willoughby Smith's method is shown in Fig. 5, which illustrates its application to communication between the Fastnet Rock, off the S.W. coast of Ireland,

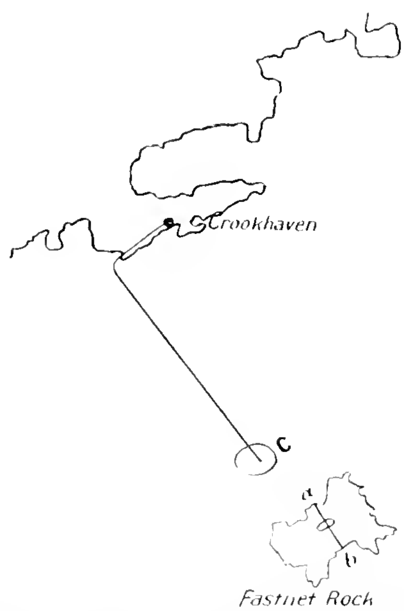

Fig. 5.—Method of Willoughby Smith and Granville employed in communicating between Crookhaven and the Fastnet Rock.

and the town of Crookhaven, eight miles away. An insulated cable from the shore is earthed at the shore end, and also by means of a heavy copper anchor, C, near the rock. A conductor, a b, containing a receiving instrument, which in this case is a d'Arsonval galvanometer, is earthed at a and b on opposite sides of the rock by connection with submerged masses of copper, and whenever a current flows through one circuit there will be a difference of potential produced at the ends of the other circuit, resulting in a flow of current which is shown by the galvanometer.

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor Alfred C. Haddon, M.A., D.Sc., F.R.S.

In the following series of articles I propose dealing with various human social groups in different stages of culture. History is not concerned—or should not be—merely with the rise, progress, and downfall of dynasties and with the doings of great men; but it takes into cognisance the evolution of the people in general. The population of any country is not an incoherent mass, but is composed of groups, and it is the business of Sociology to study the origin and history of these groups, which are subsequently welded into nations. Sociology is partly the study of the raw material of History as it endeavours to account for the idiosyncrasies of societies and groups of men whose ultimate fate is described by History. It may perhaps not inappropriately be termed the Natural History of History.

I claim no originality in the method of treatment. Several years ago I had the good fortune to assist Prof. Patrick Geddes in his stimulating Summer Courses in Edinburgh, and it was there that this method of study was brought under my notice.

My friend M. E. Demolins, editor of "La Science Sociale," has given me permission to utilise the series of sociological studies that have appeared in that highly original journal. As the system initiated by Le Play and so ably elaborated by MM. E. Demolins, R. Pinot, P. de Rousiers, Henri de Tourville, and others is but little known in this country—I have ventured to introduce it to the pages of Knowledge. There is not space here to expound the system, which after all may be best illustrated by the treatment of the several articles.

The first article is mainly an abbreviated translation of papers by M. Demolins in the first volume of "La Science Sociale," but I have not hesitated to give fresh examples and to add qualifications to many of his propositions.

I.—THE HUNTERS.

Environment.—As Europe is so largely deforested and cultured one must go elsewhere to study the hunter type in its purity. Indeed at the present day it is not easy to find people who are pure hunters. The Australians do not cultivate the soil, but their conditions of life are somewhat peculiar, and it will be better to consider the hunting folk who dwell in tropical forests where the environment is fairly uniform.

The greatest forest region is that of the valleys of the Amazon, Orinoco, and of the rivers of the Guianas, an area about equal to that of Europe.

The physical features, climatic, meteorological and geographical, which deserve a more extended consideration than can here be given to them, determine the nature of the vegetable products, which in this case constitute an immense forest. The prolonged humidity permits the growth of trees, and these by cutting off light and air stifle the growth of grass. Vegetation is rampant, savage man is powerless against it. As Bates says, "In the equatorial forests the aspect is the same, or nearly so, every day in the year: budding, flowering, fruiting, and leaf-shedding, are always going on in one species or other. It is never either spring, summer, or autumn, but each day is a combination of all three."

Occupation.—The climatic conditions and the luxuriance of the forest render agriculture very laborious, especially in the low-lying lands; the line of least resistance is found in living by hunting. There is something to be said in favour of this mode of life.

The attractions of hunting are very great. In all grades of even the most artificial or civilised societies there are people who have an almost irresistible impulse to hunt; the instinct of the poacher is similar to that of the aristocratic sportsman who slaughters half-tame pheasants or who stalks deer, or to that of the hunter who travels afar in search of big game. This fascination is evidently felt by those who are practically compelled by circumstances to become and remain hunters.

Hunting requires no foresight. An intimate knowledge of the habits of animals is necessary for existence, but no forethought is required to maintain the supply. The breeding of animals for food or industrial requirements belongs to a later stage of culture, the sole exception being the domestication of the dog, which has been more or less thoroughly accomplished by most hunting peoples.

The capture of each day provides the food of each day, and this must be consumed immediately for it cannot be preserved. Various methods have been devised for drying or smoking meat, but even so it cannot be kept for long periods like tubers or cereals.

Hunting is suited to the generality of men, for it is interesting, and it calls forth intelligence and the satisfaction of outwitting animals; it gratifies the lust of killing, and supplies an exciting element of chance, which keeps hope alive through disappointments. The food is stimulating and enjoyable. No preparatory work or thought is required to provide the supply of food. These conditions appeal to the majority of mankind.

Although there are no great possibilities in this mode of life, the chase provides for the diverse wants of man. The meat serves for food. The Eskimo prove that it is possible to live exclusively upon a meat diet; in warmer climates there are numerous edible roots, shoots, leaves and fruits which can be had in the various seasons for the picking. The skins provide clothing, materials, for habitations, vessels and the like. It is only in temperate and cold climates that clothes are necessary for warmth, and decency requires but a minimum of clothing which in tropical countries is provided by bark or leaves. The same practically applies to habitations. It is mainly the hunters of the prairies, or the inhabitants of other treeless districts like the frozen lands, who make use of skin tents. Under the same conditions various portions of the animals are employed for different purposes which the vegetable world supplies in the tropics with the expenditure of less labour to men—such for example, as fibres and receptacles like gourds. The feathers of birds furnish finery all over the world, but perhaps nowhere have they been employed to the extent that they are, and were in tropical South America. The hunters there can live isolated from more complicated societies as they are self-contained, and thus they retain a simpler and probably more primitive, social condition.

The pursuit and capture of prey require special qualities: agility, dexterity, and strength, in addition to woodcraft. These aptitudes are most particularly found among the young men, hence there arises a tendency for superiority of youth over age, unless social institutions are evolved to counteract it, as, for example, occurs in Australia. In any case the youths are early able to provide for themselves, and in consequence they set up an establishment as soon as possible. In extreme cases they retain to themselves the fruit of their labours, and repudiate the duty of assisting their aged parents. As will be stated shortly, the means for subsistence are strictly limited, and the first biologic law—that of self-preservation—is imperative, come what may.

It is one of the first duties of social organization to modify this crude state of affairs, and to prevent the children from arrogating to themselves an undue amount of authority. The arrogance of youth is a natural outcome of the feebleness of parental control.

The development of primary individualism is the result of this mode of life. This form of individualism is of the lowest, that is, of the least social, character.

It is usually to the hunter's interest to isolate himself and to hunt his prey on his own account. Some people temporarily combine to drive their quarry into nets or traps, but hunting is chiefly done single handed.

The tendency to individualism is still further developed by the facilities which hunting offers to the establishment of new and distinct households; a very different state of affairs to the value of aggregated families in sedentary communities. The dwellings of hunters are simple huts, made of branches and covered with leaves or made of skins. They are easily erected, and in the latter case are easily portable; but in warm climates a rain-proof hut can be made in a very short space of time with the materials that are ready to hand. It costs no money to make and but very little time, and no regret is felt at leaving it.

The household furniture is of the most rudimentary character, on account of the migrations necessitated by the chase. It is provided by the wood of the forest, by gourds, shells of nuts, carapaces of turtles, shells of molluscs, in fact of anything ready to hand that will serve.

The implements for the chase are quite as elementary, wooden spears, bows and arrows for terrestrial animals; a canoe and fish-spear, or a line and hook, for fishing. A few hours' work would suffice to make them all. In the district of the Orinoco there are two kinds of canoes. (1) A sufficiently large tree is chosen from which a piece of bark several yards in length is detached. This is folded and its ends strongly secured by lianas. Later the canoe is covered with leaves and placed over a great fire. This operation not only hardens it but makes it start and it only remains to caulk the cracks with a kind of gum supplied by neighbouring trees. (2) The other canoes are tree-trunks hollowed out by hatchets; although this operation is longer it is accomplished pretty quickly. Crevaux states that it takes four men only four hours to make a bark canoe. On several occasions, when stopped by a rapid, they did not hesitate to abandon one and to make another in order to continue their voyage on the other side of the fall.

There is, however, a very marked limitation of the means of existence. Game and fresh-water fish are more easily exterminated than the grass of the prairie and the fish of the sea. In our complicated societies it is necessary to frame special laws to regulate fresh-water fishing, and even the inshore marine fishing grounds are liable to depletion, and certain methods of marine fishing have to be prohibited or limited by law.

The existence of hunters is not so assured as that of pastoral or fishing communities. The game may be over-hunted or become scarce through disease or unfavourable seasons, hence hunting populations are subject to cruel famines. They cannot reserve food for these periods of famine in tropical countries, as the temperature necessitates the immediate consumption of the product of the chase. At most they can preserve meat for four or five days by submitting it to the action of a strong fire.

The question of food is the principal occupation of savages. "Our voyage," said Crevaux, "resolved itself into a regular struggle for existence. All the time we could spare from our survey and our observations was devoted to fishing and hunting."

The uncertainty of the means of existence gives to the savages a particularly accommodating stomach. They can remain several days without eating, and when food is abundant they can gorge a prodigious quantity.

The chase obliges the savage to periodically migrate. He must follow the game, or the migration of fish, or visit the banks at the turtle-egg season. Following the annual migration of the bisons across the prairies was not difficult to the North American Indians, but it is a different matter in tropical forests, owing to the tangled luxuriance of the vegetation and the general absence of paths. Hence they walk in "Indian file." So inveterate is this habit that they walk in single file when there is no occasion to do so.

The difficulty of communication is so great that there are scarcely any relations between different tribes, and from this arise a multiplicity of dialects.

The whole family has to follow the periodical migrations, and there is consequently a high mortality for the aged, sick, and even children; that is, those who cannot easily transport themselves are frequently abandoned.

It will be asked, Why do not the hunters seek in cultivation of the soil a more abundant and assured means of existence? It is probable that this has often taken place, but there are hunting communities that do not till the soil. In the district which we have more particularly under view, when game is abundant for several years, certain tribes multiply to the extreme limits of the local resources. They then manifest a tendency to agriculture; but this mode of life necessitates more effort and offers less attractions than the chase, and is especially repudiated by the young. The paternal authority which should exercise a sufficient constraint upon the latter is very feeble.

The attempts at cultivation are not persisted in and are soon abandoned; as Le Play has pointed out, "The frequent atmospheric calamities in this region of the equatorial zone happen to justify the repugnance of the population to works of agriculture. Epidemics have not only the result of reducing the tribes of the aged and the more feeble, they destroy entire tribes, and thus re-establish the equilibrium between the mouths and the means of sustenance." Such are some of the causes which oppose the transformation of hunters into tillers of the soil.

There are in the forests of the New World some very rudimentary plantations of rice, yams, sweet potatoes, sugar cane, manioc, etc. The manioc produces tapioca and a fermented drink; four days' work per month in their plantations provide sufficient food for a family of nine persons. Yet the hunters only do this to satisfy their most urgent requirements.

Despite uncertainties and cruel disappointments, the chase holds and retains the savages, and if occasionally necessity compels them to take one step towards tillage they do not persist in this effort, and return with eagerness to the more attractive work of hunting.

Property.—The forest theoretically belongs to everybody because its products are not the result of any work by man. The extent of commonage accessible to each family is much more restricted than the steppes or the sea. This limitation arises partly from the difficulties of locomotion, which confine the hunters to a relatively limited district; partly from the nature of the spontaneous productions. As these are easily exhausted the several families are obliged to energetically defend their hunting grounds against the inroads of neighbours.

If the hunting grounds are under the rule of the community this is not the case with the home and implements of work. These are personal property on account of the division into isolated households. But we have seen how restricted they are and how easy to make. This property, therefore, contributes in only a very feeble manner to develop habits of forethought and economy.

Thus the hunting savage is naturally improvident. His true property consists in his skill and agility, which he can neither sell nor bequeath. The grave question of the transmission of property does not exist for him. No tie binds, even materially, the generations with one another to induce solidarity. Individualism triumphs.

The Family.—The family cannot retain its members at home, all the children successively separate as soon as they can provide for themselves. The family periodically dissolves, scattering to found new homes as instable as the preceding. Such are the characteristic traits of the instable family, which develop the spirit of change.

The spirit of change is manifested by the preponderance acquired by the young, unless, as previously stated, special precautions are taken to prevent it. The youths, by reason of their premature emancipation and comparative isolation are not permeated by the traditions of their ancestors or the sentiments, ideas, and habits of their parents, except so far as they maintain that conservative spirit which is so characteristic of children and backward peoples.

The chief of these small families forget the memory of their elders, and take no pains to transmit the remembrance of the great actions of the race to their descendants. Verbal history, so prolix in sedentary communities, is almost non-existent among nomadic hunters.

Magical practices may be developed, but true religion —that is, the worship of a spirit or spirits—is in a very primitive stage.

Among the South American hunters not only is there no respect for their progenitors, but they may abandon and even eat their parents. The instable family often leaves orphans, the sick, the aged—in other words, the feeble and incapable—without refuge and sustenance; there is no fixed home to act as a place of refuge.

Government.—It is necessary to be young, vigorous, enterprising, if the home, children, and hunting grounds are to be protected from the incessant attacks of neighbouring tribes. Power belongs to the strongest, and is thus not only despotic but cruel.

Each tribe must be organised for defence, and for attack—it must always be on the alert. It is to the interest of the families to group themselves under a valiant chief capable of protecting them and their possessions. Thus, this state of permanent war develops a kind of personal authority; the habits of the chase render it arbitrary and cruel; the feebleness and instability of the family permit to encroach, but the authority is itself instable. Force makes chiefs, force unmakes them.

Primitive Gaul, as Le Play points out, was in a similar condition; "obliged to struggle without ceasing in order to procure their living, and to defend the game agaist the inroads of contiguous peoples, the early Gauls approached in their habits the Indian hunters whom one may still observe in the forests of America." On their arrival the Romans found the Gauls divided into a multitude of small tribes constantly at war. The policy of Cæsar consisted in setting one against another. It was the internal weakness of the Gauls that made them powerless against the Romans.

Incapacity of the Hunters to Expand.—First, there is an absence of the means of transport, being without the horse or a seaworthy boat, for bark canoes and simple dug-outs are quite unsuited for maritime navigation.

Secondly, owing to the isolation of the families there is very little communication between them, and there is a marked lack of co-ordination. Relatively small bodies of men may temporarily combine, but large enterprises are practically impossible, not only from the lack of social education, but from the difficulty of obtaining sufficient food.

Finally, the population is limited. The population is diminished by epidemics, the abandonment and death of those whom they cannot transport, intertribal wars, and cannibalism. Hunting peoples always multiply very slowly, and they even tend to disappear. The Indians of the Amazon diminish rapidly in contact with the white man, and so also do the North American Indians and the Australians. The Tasmanians have entirely disappeared.

POLARITY IN MAGIC SQUARES.—I.

By E. D. Little.

Pythagoras found the secret of the Universe in Number and Duality or Polarity, for Number is Law, and Law divides all things into complementary pairs.

The universal reign of law, the essential unity of law, and yet the diversity of its operation, the Duality or Polarity of its subject matter, all these receive abundant illustration from the number-problem known as the Magic Square, which has always had a singular fascination for the Mystic and the Mathematician alike.

The object of this paper is to show how well the least and simplest of these figures will serve for the purpose of this illustration, for although De minimis Lex non curat may be Lawyer's Law, it is not the Law of Nature. In Nature Law reigns as supreme in the least as in the greatest, and it is in the least that it is often best observed

In treating of a subject at all scientific in character it is always well to begin with definition, and our first care must be to define the nature or the note of the Magic Square. A Magic Square then is a square of numbers so arranged that the numbers in each of its rows, columns, and diagonals, amount to the same sum, as in Fig. 1, where the numbers 1 2 3 4 5 6 7 8 9 are

6	1	8
7	5	3
2	9	4

Fig 1.

1	2	3
4	5	6
7	8	9

Fig. 2.

so arranged in the form of a square that the rows 6—1—8, 7—5—3, 2—9—4, the columns 6—7—2, 1—5—9, 8—3—4, and the diagonals 6—5—4, 8—5—2, all amount to 15.

This definition calls for some comment. In the first place it presupposes a square, apart from the numbers, in which a certain construction has been made, a geometrical square which has been divided by lines parallel to its sides into a number of equal rows, and the same number of equal columns, of small squares, or positions, as they will be called.

Furthermore the definition involves a classification of the parts into which the whole figure is divided, as (1) rows of positions, (2) columns of positions, (3) diagonal lines of positions. A moment's consideration shows that this classification is incomplete. The word diagonal is not of the same extension as the words row and column.

The rows comprise all the positions of the Square, taken three at a time; so do the columns; but not so the diagonals, which in one direction comprise three positions, and in another direction three also, one of which is common to both diagonals. The classification is therefore not exhaustive. It may be made so however by extending the meaning of the word diagonal so as to include parallel to a diagonal. For with this extension the diagonals will comprise all the positions of the square, taken three at a time, in two oblique directions, related to one another in precisely the same way as the rows and columns are related. Let the positions of the square Fig. 2, be numbered in the usual or natural order.

We may then arrange the positions in four classes, according to their direction.

(1) 3 rows of 3 positions each,	1—2—3, 4—5—6, 7—8—9
(2) 3 columns of 3 positions each,	1—4—7, 2—5—8, 3—6—9
(3) 3 diagonals of 3 positions each, descending to the right,	1—5—9, 2—6—7, 3—4—8
(4) 3 diagonals of 3 positions each, descending to the left,	1—6—8, 2—4—9, 3—5—7

If we wish to distinguish (3) and (4) we may call (3) positive diagonals or + diagonals, and (4) negative diagonals or — diagonals.

We may also distinguish the diagonals in the usual sense from the diagonals in the extended sense by calling the former the middle diagonals. And we may class together the rows and columns on the one hand, and the two kinds of diagonals on the other, as laterals (for they are measured by the sides of the square), and diagonals.

We shall now be prepared for an analysis of the magic square of 3, and for a comparison of the magic square with the complement which by the universal law of things must somewhere exist. The square which stands in this relation of polarity to the magic square is shown in Fig. 3, and is called the Natural Square, and the object now in view is to establish and illustrate the completeness of the polarity existing between these two squares.

The law might be called in general terms the law of polarity in direction, but, as might be expected, it shows itself under various aspects, which will have to be considered separately.

I. Summation.—Equal summation of all rows and columns is the special note of the magic square; for in the equal summation of its mean diagonals and mean laterals it is undistinguishable from the natural square.

Now if the square in Fig. 1 be compared with that in Fig. 2 it will be seen that the + diagonals of the first are the columns of the second, and its — diagonals the rows.

The diagonals therefore of the Natural Square, and the laterals of the Magic Square have equal summation, and polarity of direction as regards summation exists between the two.

II. Difference.—Let the series 1 2 3 4 5 6 7 8 9 be regarded as a recurring series, that is to say a series in which we may begin at any point, read in either direction to either end, revert to the other end, and read in the same direction to the starting point as 4 5 6 7 8 9 1 2 3 or 5 4 3 2 1 9 8 7 6. In all these readings of the series the difference is said to be 1, for successive terms are taken at intervals of one position. Now let the series be varied by taking successive terms at intervals of 2, 3 and 4 positions respectively; it will be unnecessary to go further since by so doing we shall only obtain the same variations inverted.

The possible variations for these differences will be found to be—for

	or			
1,	8.	1 2 3	4 5 6	7 8 9
2,	7.	1	3 5 7	9 2 4	6 8 1
3,	6.	1 4 7	2 5 8	3 6 9
4,	5.	1 5 9	4 8 3	7 2 6

When the difference is 3 or 6, it is impossible to complete the series without beginning at three different starting points since the third position after 4 is 7, the third after 7 is again 1.

Now if these variations of the series be divided each into three triads, beginning with 1 in all cases except where the difference is 2 or 7, when a triad must begin with a multiple of 3, the triads will be found to be identical with the lines of the Natural and Magic squares, and the distinction between the squares to lie in the direction of the differences.

The subjoined table shows the directions of the differences in each square:—

Natural.	Differences.	Magic.
Rows	1 or 8	– Diagonals
Columns	3 or 6	+ Diagonals
+ Diagonals	4 or 5	Columns
– Diagonals	2 or 3	Rows

Thus polarity of direction as regards differences exists between the two squares.

III. Odd and Even Cross.—If the Natural and magic squares be compared as regards the position of odd and even numbers, it will be observed:

That odd and even numbers are alternate in the outside rows and columns and either in the middle laterals or middle diagonals of each.

That in the Natural Square the odd numbers all lie in a diagonal cross, the even in a lateral cross.

1	2	3
4	5	6
7	8	9

Fig. 3.

6	1	8
7	5	3
2	9	4

Fig 4.

That in the Magic Square the even numbers all lie in a diagonal cross, the odd in a lateral cross.

In this respect therefore there is complete polarity of direction between the two squares.

(*To be continued.*)

THE FLY, "SYRITTA PIPIENS."

By Walter Wesche.

A careful study of the anatomy of insects, aided by the higher powers of the microscope, though a pursuit of great interest, taxes the observer's ingenuity to account for the changed aspect of organs when rendered transparent, flattened, and mounted under pressure. The appearances presented are often likely to lead to erroneous conclusions, unless one is acquainted with the position and shape of the object in its natural condition. A knowledge of the life-history and habits of an insect is also essential if a correct idea as to the uses and purposes of the several parts are to be arrived at. For instance, there is a beautiful contrivance on the tibia of the forelegs of most of the Hymenoptera, and some of the Coleoptera, for cleaning the antennæ, which, had not Mr. Frank Cheshire observed its use, would probably be still regarded as an auditory organ. The great elaboration and specialization of different mechanisms for various purposes displayed in the anatomy of insects are only equalled by the economy of means; every part is, or has been, in some way, of use to its possessor, though what that use is is often a difficult matter to divine.

Syritta pipiens, with its complicated lancets (fig. 3); the process of knife-like setæ on the tibia of the fore leg (fig. 6), which is usually found in predaceous flies

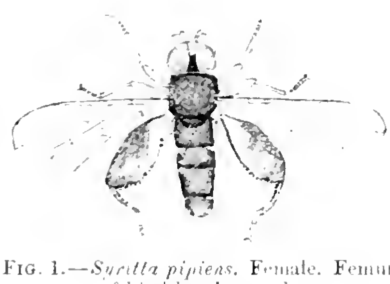

Fig. 1.—*Syritta pipiens.* Female. Femur of hind leg flattened.

and beetles, and used in holding prey; the many chitinous setæ on the tarsi of the middle leg, disposed in fairly regular patterns (fig. 5); and the remarkable hind leg (fig. 4), which at first view seems adapted to the curbing of the struggling wing of a powerful opponent, might incline to the opinion that the fly was raptorial, and used these parts in pursuit and capture of its prey. The insect is very well known and common from April to October. It belongs to the family Syrphidæ, or "Hover flies," and feeds on the pollen of flowers, of which its abdomen may often be found full.

Fig. 2.—*S. pipiens.* Male.

It is figured and described under the name of Musca pipiens in the work of the old French entomologist, De Geer, and so exhaustively that most later writers quote his observations (Westwood and others). It was named from its habit of uttering an exceedingly acute cry when held, the sound being produced through the two large pear-shaped spiracles on the thorax. De Geer found the larvæ in the dung of horses and cows; it is thicker in front than behind, and has a small point on the head.

The male (fig. 2) is a little smaller than the female,

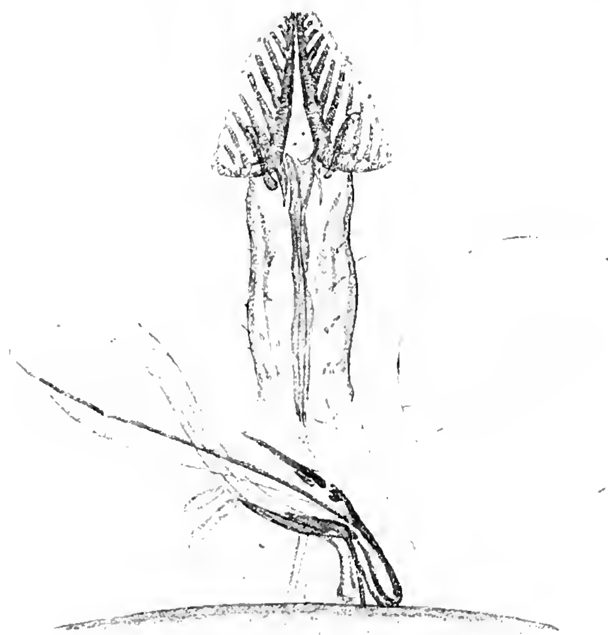

Fig. 3.—Mouth organs of *S. pipiens*, proboscis, lancets, and maxillary palpi; smaller circle has tip of lancet more magnified and showing hairs. × 46 diameters.

as is usually the case in insects, and the mouth organs and legs do not differ, with the exception that the male carries a series of very short chitinous spines on the coxæ of the hind leg—"a secondary sexual" characteristic, enabling him to hold the female in a firm grip (fig. 4). The same process is to be found on the males of Erystalis (bee or drone fly). The coxæ of the female are quite plain, and both sexes have a pretty and delicate fringe of hair on the abdomen to protect the femur of the hind leg from the effects of chafing. The male, in its markings, also differs from the female, these external characteristics being larger and lighter on the dorsal region of the abdomen, and there is a smaller space between the eyes (facies).

This fly may be seen on a sunny day hovering over flowers, or busy with the pollen, and is described as having a "characteristic quiet manner of moving on a plant."

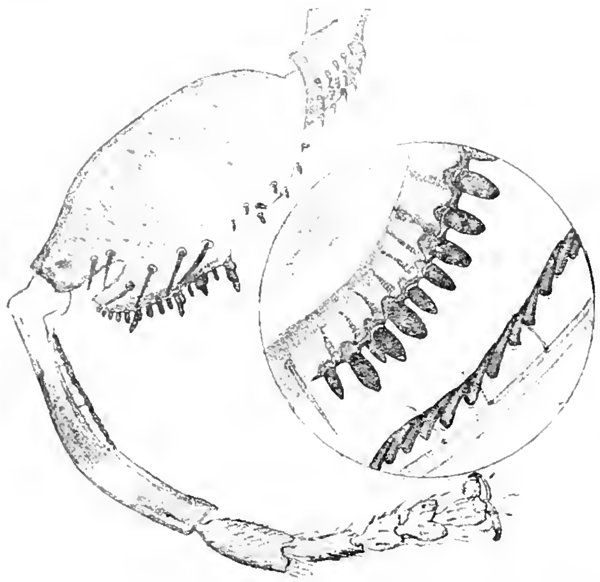

FIG. 4.—Hind leg of *S. pipiens*; the smaller circle shows the processes on the edge of the femur and tibia more magnified. × 22 diameters.

It will be seen on examination of the mouth organs (fig. 3) that there are no pseudo trachæ on the labella of the proboscis, and no teeth; also on looking at the smaller lancets with a power of three hundred and fifty diameters, that they are not piercing organs, but bear a very delicate series of fine hairs on the tip (small circle on fig. 3).

The hind leg (fig. 4) is truly remarkable; the process of blunt knobs or teeth on the femur, and of bent

FIG. 5.—End of tibia, and part of tarsi of middle leg, of *S. pipiens*. × 94 diameters.

FIG. 6.—End of tibia of fore leg of *S. pipiens*. × 125 diameters.

spines on the tibia, are contrived to lock on to each other and so constitute a sort of pincer. From its extraordinary elaboration and powerful construction it must play an important part in the insect's life-history; it is probably used in crushing some kind of capsule or part of a flower to admit of the pollen being extracted. By careful focussing with a power of three hundred and fifty diameters, some minute trachæ may be detected above the knobs on the femur (small circle, fig. 4.)

It is possible that the spines on the tibia may be capable of erection, as there appears to be some trace of a muscle underneath them. Of the uses of the setæ on the middle and fore legs it is difficult to form an idea; they may be the remnant of former useful appendages, the insect having changed its manner of obtaining food, but from their very marked character and the modification which in that case has taken place in the lancets, leaving them unmodified, this is very improbable; besides, the spines at the end of the tibia of the fore leg are found in most, if not all, of the Syrphidæ.*

An antenna is shown in fig. 7. It resembles Syrphus balteatus and others of the family; the small circular markings are probably olfactory organs, and would be of service to a flower-feeding insect; at a deeper focus there is a curious organ of a rather vermiform appearance, which seems to be for the same purpose. The male organs are very interesting, and can seldom be so well seen as in this fly—though even here it is far from easy to make a satisfactory diagram (fig. 8); two large feeling organs, two "claspers" (fig. 9), and two inner "holding organs" (fig. 10), as well as a seminal duct, are all clearly seen, but other parts are very nebulous,

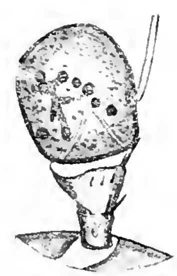

FIG. 7. — Antenna of *S. pipiens*. × 50 diameters.

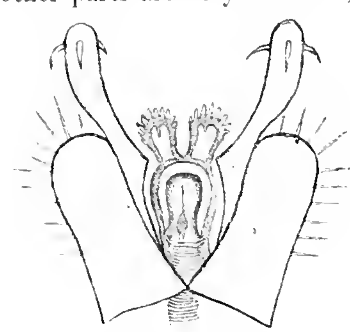

FIG. 8.—Diagram of the hypopygium of *S. pipiens*.

overlap, and difficult to differentiate. The apparatus shown in fig. 10 is a very pretty microscopic object, and with the "claspers" (fig. 9) (note how the setæ are turned back so as to form hooks) and the process on the coxæ of the hind leg, are obviously all modified with the object of accentuating the male's firm hold of the female. The remarkable elaboration and complexity of detail on this minute fly (the female is $\frac{3}{8}$ of an inch long, the m le a little less), cannot fail to strike an observer. It is interesting to compare this insect with another nearly related to it. Ascia podgrica is rather smaller, and the abdomen very different in shape, being a pointed oval tapering with a curve to the base, but the wings, the fore legs, and the mouth organs are identical; the femur of the hind legs is thickened in precisely the same manner, but it is toothed with sharp setæ, and there are no spines on the tibia, the edge being hardened and chitinous instead; the middle legs lack the elaborate spines, and the antennæ are slightly different in shape. Erystalis pertinax and Heliophilus trivittatus carry a

* I have had an opportunity of watching, at all events, one of the uses of the hind leg; a female extended her long membranous ovipositor and drew it very carefully through the teeth of the femur and tibia, which were compressed for the purpose; this was repeated many times. I am inclined to think that the numerous hairs and spines on the legs are primarily intended for cleaning purposes.

NEBULA H IV. 41 SAGITTARII.

By ISAAC ROBERTS, D.Sc., F.R.S.

similar apparatus on the hind leg, but the femur is not nearly so thickened; it is armed with sharper spines than S. pipiens, and the tibia is furnished with a similar

Fig. 9.—"Clasper" of male *S. pipiens.* × 100 diameters.

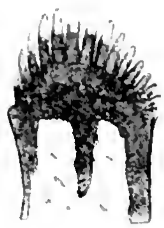

Fig. 10.—"Holding organ" of male *S. pipiens.* × 275 diameters.

process, though not quite so continuous. The explanation of these variations forms an interesting problem, which with opportunity for observation, I do not think is incapable of elucidation.

In conclusion it is my duty and my pleasure to express my obligations to Mr. E. Austen, of the British Museum, for information on the life-history, literature, and the kind gift of specimens of S. pipiens.

PHOTOGRAPH OF THE TRIFID NEBULA Ħ IV. 41 SAGITTARII, AND OF THE REGION SURROUNDING.

By Isaac Roberts, D.Sc., F.R.S.

The photograph annexed is of the region in the sky comprised between R.A. 17h. 54m. 12·8s. and R.A. 17h. 58m. 42·1s., and in declination between south 23° 37′·6 and 22° 16′·6. The area, therefore, is 4m. 29·3s. in extent from *following* to *preceding*, and 1° 21′ from north to south. Scale—one millimètre to twenty seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch 1900.

Star (.) D.M. Schonfeld No. 4503 Zone −22° R.A. 17h. 55m. 50·8s. Dec. S. 22° 46′·1. Mag. 6·0.
Star (..) D.M. No. 4533 Zone −22° R.A. 17h. 57m, 53·6s. Dec. S. 22° 50′·7. Mag. 7·4.

The *Trifid* nebula Ħ IV. 41 is in R.A. 17h. 56m.; declination, south 23° 2′.

References.

N.G.C. No. 6514. G.C. 4355. *h* 1991=3718. *Phil. Trans.*, 1833, Pl. XVI., Fig. 80. *Cape Obs.*, Pl. II., Fig. 2.

The photograph was taken with the 20-inch reflector, and exposure of the plate during 90 minutes, on the 13th July, 1899; and it will be observed that the nebula is characterized by tortuous dark rifts without stars in them. Those which intersect the denser part of the nebulosity have margins sharply defined, whilst those in the fainter parts are broader, with the margins less defined and some nebulosity in the rifts.

There have been published in Knowledge, during the past two years, three photographs showing the densely dark rifts, and besides those, others showing the broader rifts; amongst the latter the nebulæ in Orion and in Andromeda are conspicuous examples, as well as those of the cloud-like class.

The inferences we may reasonably draw from these appearances are that those nebulæ are developing into the more stable form of stars by the influence of gravitation. They appear to be the earlier stages in the development of spiral nebulæ, examples of which have been shown on many photographs already published, where it was obvious that the nebulosity is aggregating into stars in the convolutions.

The most useful work that can now be done for the advancement of astronomical science is the careful measurement of the position angles and distances of the sufficiently well defined star-like condensations of the nebulosity in these various nebulæ from selected normal stars, six or eight in number, which surround the respective objects within the radius distance of one degree or less. In this way astronomers would, within an interval of a few years, be able to demonstrate the changes that have taken place in these bodies with reference to those stars as fiducial points; and thus positive knowledge would be gained in place of the speculative with its never ending controversy.

It is welcome intelligence that Dr. Dreyer, of the Armagh Observatory, is about to commence the attack upon this work.

ASTRONOMY AND ASTROLOGY; A QUESTION OF PRIMOGENITURE.

By E. Walter Maunder, F.R.A.S.

No record exists to tell us under what circumstances, and exact form, the science of Astronomy had its first beginning. We can, therefore, but make a guess as to its origin, and most of our leading writers are at one as to the agent which gave it birth. Astronomy, say they, is the daughter of Astrology.

It may seem presumptuous to call in question an idea which writers, of such sound judgment and keen perception as the late R. A. Proctor, have regarded as axiomatic, but, in my own view, Astrology, so far from being the parent of Astronomy, must be looked upon as a late and most degenerate descendant from the sublime science.

Astronomy, like everything else, had a beginning. There must have been a time when men had not yet discovered that the stars seen on one evening held the same relative positions as those observed the next; a time when no planets at all had been recognised, and when the sun and moon were not thought to be of the same order as the other heavenly bodies.

An unintelligent townsman of to-day, who may perchance find himself out in the country on some dark, clear, night, looks up and remarks casually, that "It is a lovely night," and "What a lot of stars there are out," and there his knowledge and recognition of the spectacle end. He knows no constellations, he recognises no particular stars; he has never watched the heavens long enough to discern that they are continually turning round the pole; a planet and a fixed star are both alike to him; the heavens present no problems, give no information to him.

Now this state of things, which we find only too widely prevalent to-day, much to the discredit of our modern civilization, must once have been universal. There was a time when no one could recognise a constellation, because none had yet been mapped out; when none could tell the difference between a planet and a fixed star, because no observations had at that early date been devised for following the movement of the one, or proving the immobility of the other.

Let us turn, on the other hand, to a consideration of the knowledge which is involved in the exercise of astrological art. Supposing that a modern astrologer were asked to calculate the nativity of some client, he would proceed substantially in the way in which Sir Walter Scott describes Guy Mannering as doing at the birth of Henry Bertram of Ellangowan.

> "He erected his scheme or figure of heaven, divided into its twelve houses, placed the planets therein according to the ephemeris, and rectified their position to the hour and moment of the nativity. Without troubling our readers with the general prognostications which judicial astrology would have inferred from these circumstances, in this diagram there was one significator which pressed remarkably upon our astrologer's attention. Mars having dignity in the cusp of the twelfth house, threatened captivity, or sudden or violent death, to the native; and Mannering, having recourse to those further rules by which diviners pretend to ascertain the vehemency of this evil direction, observed from the result that three periods would be particularly hazardous—his fifth, his tenth, his twenty-first year."

The foregoing sketch of an astrologer at his work will be a sufficiently accurate one for our purpose, no matter what the time or the nation in which he is supposed to have lived.

Now what is involved in the operations which Guy Mannering performed? First of all, they imply that the constellations had been devised and mapped out; next, that the planets were recognised as such, and these are inferences with very significant consequences. The recognition of "the seven planets," though it came so early in the history of the world that there is a numerous school which believes the week is a consequence of such recognition, was no simple matter. It was a triumph of careful observation and clear induction which led the early astronomers to see that Hesper and Phosphor, the evening and morning stars, were not two bodies, but one. Much more difficult was it to track the elusive Mercury, and recognise in it again a single wanderer. Mars and Jupiter would be followed with much greater ease, but the dull and slow moving Saturn could only have revealed itself as a planet when observations of the relative positions of the stars had become systematic and it was known from definite measurement of some sort or another that of all the stars, these five and these alone, moved with respect to the others.

The recognition of the remaining two of "the seven planets" must have been no easy matter, and implies a power of looking behind the mere superficial appearance of things in the highest degree creditable to the early workers in our science. For the effect produced by the sun and moon on the mind of the casual spectator is certainly that of an altogether different order and kind from the stars and other planets. Of course, it was easy to perceive that the moon moved amongst the stars, although its motions differ in several important characteristics from those of any of the planets, but he must have been both a clear and a bold thinker who first told his fellow men that the stars were shining down upon them all day as well as all night, and that the explanations of the changes in the constellations visible at different seasons of the year was that the sun was moving round amongst them in the course of a year, as the moon did within the limits of a month.

All this pioneer work must have been done, and done thoroughly—become familiar and commonplace long before the very first step in astrology can have been taken. Men cannot possibly have conceived that Jupiter brought good fortune, or Saturn sinister, before they had recognised the existence of those planets, and that they moved differently from the common herd of stars.

If we assume that at some early date men had come to look upon certain of the planets as favourable, and others as unfavourable, we can readily see that an Astrologer who could take an actual observation of the heavens at the moment of the birth of some Prince, or of the starting of some expedition, or the laying of the foundation of some building, could come to the conclusion that the person or enterprise would be prosperous or the reverse. But that was not the chief object of Astrology. The principal point was to find out beforehand at what time in the life of the new-born Prince he would be most exposed to danger or most likely to meet with good fortune. This was the actual case with Guy Mannering's prediction of Harry Bertram. So in the event of an expedition, or enterprise of any kind, the duty of the Astrologer was to choose in advance a favourable moment for its commencement. And in both cases this demanded on his part a very precise knowledge of the future position of the planets. A complete horoscope, indeed, involves the knowledge, not merely of the places of the planets that are above the horizon at a given time, but also those that are below. This meant a mastery of the apparent movements of the planets, which can only have been obtained after centuries of the closest observation. In other words, the existence of Astrology pre-supposes a state of Astronomy not less advanced than it was in Alexandria under Claudius Ptolemy, or in Samarkand under Ulugh Beigh.

More than this, Astrology bears witness to a previous Astronomy, then half forgotten. The signs of the Zodiac of the astrological scheme are not in the least the actual Zodiacal constellations, though they derive their names from them. They are simply a method of recording celestial longitude, and bear no relation to the configurations of the actual stars.

Yet whenever and however Astronomy first arose, the initial step towards progress must have been the mapping out of the stars into constellations; until that had been done it was impossible for men to be sure that the stars they could see maintained the same relative positions towards each other. Not until that fact had been assimilated was it possible to appreciate the next, namely, that certain stars were planets, wandering amongst the others. Then when the constellations had been formed, there must have come quickly the recognition that different constellations were visible at varying times of the year, and this led on no doubt at once to the idea of adapting the science to utilitarian purposes.

Both tradition and, it seems to me, the inherent probability of the thing, support the belief that the first use of Astronomy was the determination of the length of the year and the announcement of the return of the seasons in their due course; and this must have been a service of the very first magnitude. For although the early agriculturist could learn from flowers, or plants, or trees when Spring was approaching, yet these phenological indications are somewhat vague and indefinite, and will vary considerably even in neighbouring districts.

No doubt the chief duty of the early priests and astronomers, to whom the task of watching the heavens was intrusted, consisted in noting the heliacal rising of certain special stars to be able to announce the return of the different seasons of the calendar, and in all probability it is in these observations that we can see the first germ of the notion of Astrology. For the seasons in their course naturally bring with them their own characteristics—seed-time and harvest, cold and heat, drought and flood, fevers and agues, and the like; and it would be easy to associate these various phenomena with special stars, and to ascribe them to the stellar influence.

Such astrology, however, would be a purely stellar astrology, not susceptible of very much development. Astrology, as we know it, on the other hand, is almost exclusively planetary, and very nearly independent of any such simple considerations as the return of the stars to their heliacal rising at the end of the year.

Another application of Astronomy which must have been considerably later than that of its use for the determination of the calendar, and yet which was certainly an early one, is its use in navigation, taking the word in a wide sense to mean not merely the steering of a ship across the sea but also a caravan across the desert. Here it must have been early appreciated that the stars afford absolutely the best finger-posts by which to cross the pathless and monotonous ocean, and no doubt it was soon understood that not only did they give the means for determining the cardinal points but also for ascertaining the latitude of the traveller. The sailor who was thoroughly acquainted with the stars would have no difficulty in navigating from one port of which he knew the latitude to any other whose latitude was also known. He had but to sail north or south until the elevation of the Pole Star assured him that he was on the proper circle, and then he would sail east or west, as the case might be.

There must have been a very wide demarcation in early times between the Astronomy of the Calendar, without doubt in the hands of a small and mysterious cult, and the Astronomy of Navigation necessarily in the keeping of practical sailors. The latter would certainly have not lent itself to astrological ideas, and though we may owe several of our constellations to these early sailors they are not likely to have done much to give the science a fortune-telling character.

Very different indeed would have been the position of the priestly astronomers if by dint of careful observation and research they were able to go beyond their original work of arranging the calendar, and were able not only to divine the causes of eclipses but to foretell them. If they attained to this mastery of the laws of Nature then they had a power in their hands which could be readily used for political or religious effect to an almost unlimited extent, and which would at the same time serve as a foundation upon which an infinitude of further claims might be safely based. To this very day no astronomical feat whatsoever obtains such wide and complete popular recognition as the computation of the time of an eclipse, and in those early ages the occurrence of an eclipse in accordance with prediction must not only have seemed to invest the astronomer himself with superhuman powers, but must have convinced the people beyond all chance of confutation that the movements of the heavenly bodies were intimately connected with the affairs of men. The successful prediction of an eclipse was probably regarded at once as a certificate of the skill of the Astrologer and a demonstration of the reality of Astrology.

Nevertheless, when once the imposture had been fairly set afoot of predicting the fortunes and fates of men from the movements of the heavenly bodies, the predictors must have speedily found themselves short of material upon which to go. The return of stars to their heliacal risings in the course of the year would be far too regular a phenomenon for anything but general prophecies to have been based upon it, and eclipses are too rare for anything but occasional use. The sheer necessity which a fortune-teller would have for a wide range of combinations, applicable at any and every moment, must have driven the old soothsayers and seers to the use of the planets as their stock in trade, directly the science of actual observation had been so far advanced, that they could both predict a planet's place in the future, or calculate back its position in the past. The infinite diversity of grouping which the planets offered, lent itself so precisely to the needs of the imposture that once started the pseudo-science developed with amazing rapidity.

The rise of Astrology would seem to have meant a complete arrest of the development of the parent science—Astronomy. The Astrologer needed his tables of the sun, moon, and planets. He required some instrument for observing the altitude and azimuth of a celestial object. Ability to make at least an approximate determination of time was a desideratum, but given a science which would supply him with this information, and he stood in need of nothing more. He boldly translated the celestial movements into terms of human history, and predicted wars and revolutions, plenty or famines, as the result of the planetary positions. It did not occur to him to follow these positions for themselves or to speculate as to how they were brought about. Had a doubt as to the Ptolemaic system been suggested to him it would, likely enough, have seemed idle and abstract controversy. The astrological significance of a given position of Mars was just the same, whether its real centre of motion was the earth or the sun. Astronomy, therefore, which had made so great a progress before Astrology could have made a start, remained perfectly dormant during the long ages when men studied the heavens not to get a better knowledge of the laws of Nature but simply, if possible, to lift the veil which hid their own future. And when once again men began to inquire as to the real physical meaning of the movements of the planets, Astrology decayed as rapidly as it had grown. The arguments of Copernicus, the telescopic discoveries of Galileo, the laws of Kepler, though they have no direct bearing on the truth or falsity of Astrology, yet by directing men's minds to the true problems which the heavens offer, speedily put an end to the absurd inventions which had enchained men's minds for so many generations.

We are able to indicate roughly how far back both Astronomy and Astrology are traceable. Assume the mapping of the constellations amongst the first of Astronomical operations. Now the old constellations which have been handed down to us through the medium of the Greeks, from the old inhabitants of Mesopotamia, received their completion not quite 3000 years B.C. This we know, since, as has been frequently pointed out, the region in the Southern heavens which the Astronomers of old left unmapped, is one the centre of which coincided with the Southern Pole a little less than 5000 years ago. This then gives us the date of the completion of the constellations. How long they had taken to map out we cannot tell, whether it was a few months, a few years, or several centuries. Yet we can be sure that it was not an indefinitely long time for whilst many traditions in different forms remind us that Taurus was once the equinoctial constellation, there is no tradition that Gemini ever held that place.

When we come to Astrology, however, we find the indubitable marks of a much more recent origin. First of all, as already pointed out, the astrological signs of the Zodiac have nothing to do with the actual stars; the constellations to which they owe their names are left quite out of sight and are almost forgotten. Next, and most significantly, we find that Aries is the primitive sign of the Astrological scheme. There is no hint that it ever had been Taurus. This fact would of itself suffice to show that Astrology, at any rate in any such systematised form as we now know it, is far younger than Astronomy, younger by the time which precession takes to cross an entire sign of the Zodiac, younger, that is to say, by a period which we may roughly put as 2000 years. No doubt sun-worship and moon-worship reach back almost to the birth of the human race; no doubt eclipses, comets and meteor-showers struck terror into men from the earliest ages, and many superstitions and fancies of an astrological tendency took form and shape in primitive times and prepared men's minds to accept the imposture when at length it had attained an organised development; but we can say positively that Astrology in anything like a complete system cannot date back earlier than 1800 B.C., when the sun first entered Aries at the Spring Equinox, and that it must almost certainly have arisen many centuries later.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

IS THE UNIVERSE FINITE?

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Of course the academical question, whether the Universe is finite or infinite, is not likely to be solved in our time, and I do not think that the difficulties raised by some correspondents of your journal, and elsewhere, about our idea or conception of the infinite will afford us the least assistance in arriving at the solution. The structure of the Universe is a very different thing from our ideas or conceptions of it.

But the question which occurred to Mr. Burns, and had previously occurred to others, is in reality a different one. It is this: Is the Universe confined within limits which we may reasonably expect to ascertain and define—for instance, within a sphere with the sun (or earth) as centre, and a radius equal to 100,000,000 times the sun's distance from the earth? In fact a sphere with a considerably smaller radius than this would account for everything that we at present know. But although this explanation is admissible, there are grounds for doubting whether it is the true one.

Mr. Anderson, I think, falls into a very common error on this subject, by supposing that nothing can affect the eye unless it can be separately seen. The current theory at present is that Saturn's rings consist of meteors. What would be thought of an astronomer who contended that the ring must be invisible because the meteors cannot be separately seen? Again: look at the Milky Way on a clear, moonless night. It is perfectly visible to the naked eye; but can it be said that our most powerful telescopes, whether used by the eye or on the photographic plate, have as yet resolved all this luminosity into separately visible stars? The zodiacal light and the Gegenschein may be cited in further illustration of this. Stars or other objects, which no one has as yet succeeded in rendering separately visible, do unquestionably affect the naked eye; and if we find that the general illumination of the sky falls much short of what it ought to be on any given theory, we cannot explain this fact by supposing that stars of less than a given magnitude produce no effect at all. Take a single meteor at the distance of Saturn and of the average size of those which compose the rings; regard this meteor as a star, and of what magnitude will it be?

Bright stars lose as much by absorption, atmospheric or telescopic, as fainter ones. Hence, we may neglect the element of absorption when dealing with the total light of stars of different magnitudes. It is, of course true that "if the illuminating area were to decrease, owing to increase of distance, more rapidly than it increased owing to greater numbers. . . it would never give us a blazing sky," as Mr. Hill says. But this could not occur without a constant thinning out of the stars as we pass to greater distances from the solar system. On the hypothesis of uniform distribution, when the light of the stars decreased in the proportion of 2.512 to 1 (one magnitude) the number would increase in the proportion of 3.984 to 1, and the total "illuminating area" would be more than 1½ times as great as before. Mr. Burns, I apprehend, did not seek to prove that the stars could not extend to infinity. What he sought to prove was that they could not do so unless there was a constant thinning-out on the way. The question is almost equivalent to this: Is the sun a member of a star-cluster?

Admitting, however, that the sun is a member of a cluster, the chances are that it is not in the centre of the cluster; and, if so, this thinning out of the stars ought not to take place at once. But if we take in the entire sky, as far as I can judge, the apparent thinning-out begins almost at once. Hence the existence of an absorptive medium of some kind in space is naturally suggested.

W. H. S. Monck.

LUNAR SEAS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I hope Mr. Tepper's very thoughtful paper and Mr. Tappenden's letter in your last issue will revive an interest amongst your readers in the study of lunar cosmogony.

The theory suggested by Mr. Tepper has so many things in its favour that I cannot think it unimportant; the fall of meteors on its surface, where no atmosphere exists, certainly suggests a plausible origin for the rays from Tycho and other ring craters as we call them. I am not sure but some of the craters themselves may have originated by the fall of large meteors coming down vertically into a deep coating of such dust as Mr. Tepper speaks of, and might explain the radiating rays, whilst meteors moving obliquely would explain the rays which run parallel to each other, and there are many such.

The large plates of the French photographs by Loewy and Puiseux will be of very great value in the study of lunar questions; the part of one of these published in December Knowledge shows many important points, which answers some of the suggestions. The ray below Bullialdus (E) does not run into the crater Tycho but passes close to its eastern wall, and can be traced running in the same direction on the other side, and we can easily trace another ray running parallel to it farther east, as if a meteor had ploughed through some loose matter, forming a furrow and throwing the material on each side of its track. There is also another running parallel with these on the west side of Tycho. It appears to me as if a number of meteors swept over this part of the moon in the same direction at the same time.

Mr. Maunder speaks of Kies and Lubiniesky as having sunk in the invasive fluid. May it not be that these rings were perfect before the rays referred to were formed, and that the matter thrown from the meteor's track has buried these rings?

Another group of parallel rays sweeps north westerly from Kircher and Bailly, over Tycho and on to Lexell. I think Mr. Tappenden's suggestion that the rays are the results of meteor flights and falls may be the true explanation.

December 17, 1899. A. Elvins.

S. S. CYGNI.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—We have had a remarkable appearance of S. S. Cygni during the last two weeks, quite unknown to our experience. For myself I will say I did not believe my eyes, and sought for light, but my observations which are as follows have been fully confirmed:—

1899.		Mags.	1899.		Mags.
Nov. 21.	Cloudy		Dec. 1.	9 p.m. ...	9·20
„ 22.	7.30, 8 & 9 p.m.	10·5	„ 2.	8 p.m. ...	9·20
„ 23.	8 p.m.	<10·00	„ 3.	7.45 & 9 p.m. .	9·25
„ 28.	„	9·37	„ 4.	7.30 p.m.... ...	9·30
„ 29.	„	9·30	„ „	9 p.m.	9·35
„ 30.	„	9·20	„ 5.	7.30 p.m.... ...	9·55
			„ 6.		<10·00

The weather since has been cloudy. The maximum may be put on the 1st December. The star on previous apparitions rose on second or third nights to about 8.5m.

David Flanery.

Memphis, Tenn., U.S.A.,
9th December, 1899.

Obituary.

John Ruskin, whose death, on the 20th January, 1900, we regret to record, was born in 1819, the son of a wine merchant in London, and was educated privately and at Christ Church, Oxford, carrying off the Newdigate Prize. His love of art found expression in his early attempts at painting, and in the pamphlet written by him in defence of Turner and his method, which was afterwards expanded into the great work—"Modern Painters," the five volumes of which, illustrated by himself, appeared between 1843 and 1860. "His besetting sin," says Frederick Harrison, "as a master of speech, may be summed up in his passion for profuse imagery and delight in an almost audible melody of words." Indeed, it is generally conceded that Ruskin not only surpassed every contemporary writer of prose, but called forth out of our English tongue notes more strangely beautiful and inspiring than any ever yet issued from that instrument. "No writer of prose before or since has ever rolled forth such mighty fantasies, or reached such pathetic melodies in words, or composed long books in one continued strain of limpid grace." "All my life," he once said, "I have been talking to the people, and they have listened not to what I had to say, but to how I said it; they have cared only for the manner, not the matter. For them the kernel is nothing: it is the shell that attracts." In 1849 appeared his "Seven Lamps of Architecture," followed by "The Stones of Venice" (1851-53), "Lectures on Art," 1859, "Unto This Last" (1862); "Ethics of the Dust," and "Sesame and Lilies," 1865; "Crown of Wild Olive," 1866, and others. Ruskin was Slade Professor of Art at his own University, and Rede Lecturer at Cambridge. His autobiography, under the name of "Praeterita," appeared in parts a few years ago. The venerable Dean of Westminster offered to the relatives a space in Westminster Abbey in Poets' Corner for the entombment of the great critic and philosopher, but, adhering to Mr. Ruskin's previously expressed wishes, the distinguished man of letters now rests in the churchyard at Coniston.

It is with much regret that we have to record the death of Dr. Elliott Coues, the well known American Zoologist, who died at Baltimore, on December 25th, aged 57. Dr. Coues began life as a surgeon in the U.S. Army, in which position he had unusual opportunities for travel. The results of his collections of birds and animals made during these expeditions were published in various scientific journals. In 1872 he published a most valuable "Key to North American Birds." Among his other works may be noted, "Birds of the North-West," "Field Ornithology," "Birds of the Colorado Valley," and in conjunction with Mr. J. A. Allen, "Fur-Bearing Animals." Dr. Coues was best known as an ardent and accomplished ornithologist, not only in America but also all over Europe. As a man he was most genial and affable, and his loss will be a great one, as well to his friends as to the scientific world at large.

Notices of Books.

A System of Ethics. By Friedrich Paulsen. Edited and translated from the fourth German edition by Frank Thilly. (Kegan Paul.) 18s. net. Since, as Matthew Arnold wrote, "Conduct makes up three-quarters of life," the science concerned with studying and formulating the laws which govern right conduct is of the very highest importance. We welcome Professor Thilly's translations of Professor Paulsen's valuable contribution to this study, because being written primarily for those who are personally interested in the problems of practical philosophy and not for the philosophical expert, it can be easily understood by the ordinary intelligent person who reads carefully. The translator has used a wise discretion in omitting certain sections of the original treatise which only possess a more or less local interest for the German public. The first portion is devoted to the historical development of the conceptions of life and moral philosophy from the times of the Greeks down to the present; the next examines the fundamental questions of ethics; while the third division of the book is concerned with the application to daily conduct of the principles previously discovered. It will serve to indicate roughly the author's philosophical position if some of his views on crucial questions are briefly stated. He is an advocate of the *teleological* as opposed to the *formalistic* view of the difference between good and bad—that is to say, from Professor Paulsen's point of view, "acts are called good when they tend to preserve and promote human welfare; bad when they tend to disturb and destroy it." To the question, "What is the end of all willing?" the *energistic* and not the *hedonistic* answer is given. "Not pleasure, but the 'objective content of life' is the highest good at which the will continually aims." "The highest good of an individual as well as of a society consists in the perfect development and exercise of life." Nor is the author a pessimist; in one place he says, "philosophical pessimism is not a proved theory, whose propositions can lay claim to universal validity, but the expression of individual feelings, and as such can be merely subjectively true." Or, again, "inasmuch as we have no statistics on the happy and unhappy lives, the successes and failures, I am for the present inclined to put as much faith in the judgment of a plain man of the people as in the eloquence of a pessimistic philosopher." But interesting quotations could be multiplied indefinitely. When it is said that some of the headings of separate chapters are "Duty and Conscience," "Virtue and Happiness," "Relation of Morality to Religion," "Suicide," and "Justice," it becomes abundantly evident that the volume is brimful of information interesting to every thoughtful man and woman, and as, added to this, the translator has succeeded throughout in writing clear and pleasing English, it is quite certain that the book will be widely read.

Impressions of America. By T. C. Porter, M.A. (OXON.). Illustrated. (C. Arthur Pearson, Ltd.) 10s. 6d. Mr. Porter tells in simple, chatty language, the story of a hurried visit to America. He travelled from New York to Niagara, thence to the Yellowstone Park, San Francisco, Yosemite, Utah and the Colorado Springs. The author is not strong in painting word-pictures, indeed, his pen sometimes halts rather painfully, but yet the narrative as a whole is quietly pleasing. At the same time a great deal of information about the show-places of America can be learnt from the book, and Mr. Porter's experiences cannot fail to be useful to anyone who intends taking a holiday of a similar kind. The reader's attention is directed almost entirely to scenic effects, examples of earth sculpture, and kindred topics. The ways of men in these western places are scarcely touched upon at all. The most noteworthy characteristic of the volume is undoubtedly the fine collection of stereoscopic plates which accompanies the text, and a stereoscope is supplied with the book for the proper examination of the plates. Though Mr. Porter's clear explanation in the introduction will enable many readers to obtain the stereoscopic effect without any instrument, the person who objects to a little preliminary trouble will be glad of this novel addition to the volume.

The Universal Illusion of Free Will and Criminal Responsibility. By A. Hamon. (University Press, Limited.) 3s. 6d. Criminal anthropology, in the hands of Professor Lombroso's followers, is advancing rapidly. Sociology and psychology constitute very plastic materials out of which these students can mould ethereal forms not altogether agreeable to the average citizen of the world. Sample: "The criminal is normal, and the honest man an anomaly. I defy the refutation of this assertion if, by criminal, is meant the author of an injury to the community or to an individual." For an acquaintance with the multitude of facts put forward to uphold such assertions as this the book itself must be consulted. We are, according to the author's teaching, practically automatons. Marriages, crimes, suicides, emigration, births, mortality, and so on, are the resultants of many forces—social, physical, and cosmic. Free will, the helm by means of which some of us imagine we steer the human ship, is denied.

The Romance of Wild Flowers. By Edward Step. (Warne.) Illustrated. 6s. No pleasanter companion could very well be imagined than Mr. Step in his communings with Nature. Roses and apples, buttercups and columbines, violets and pansies, harebells and heather, all these give pleasure as the eye glances down the pages, and the pictures almost emit the sweet odours which the plates recall to the memory. It is a book to put flower lovers merely on speaking terms, as it were, with Nature, and is not intended for the scientific botanist.

An Introduction to the Study of Zoology. By B. Lindsay. (Sonnenschein.) Illustrated. 6s. Students of biological science are too frequently retarded at the outset through lack of information concerning the means necessary for amplifying their knowledge outside the very limited scope of a first book on either of the two branches of the science—zoology and botany. Mr. Lindsay has anticipated these difficulties by chapters on the use of books, biological stations which have been established on the British coast for the study of marine biology, lists of persons who can supply specimens and tools to work out the practical details, and so on. All this, added to the usual text, raises Mr. Lindsay's book to a high level among introductory works of this kind.

The Reliquary and Illustrated Archæologist. Vol. V. 1899. (Bemrose.) 12s. net. We are pleased to observe that this quarterly continues to sustain the reputation it has so long enjoyed as a first-rate magazine of antiquities. The editor, Mr. J. Romilly Allen, merits the thanks of all interested in the survivals of ancient usages and appliances. The rich store of information here gathered together from many and widely separated sources for our quiet enjoyment at home without the trouble and inconvenience of travel are a real boon. The contents vary from a glass linen smoother to a cathedral, and from a tiller of the soil to a Roman Emperor.

Matter, Ether, and Motion. By Prof. A. E. Dolbear. (S.P.C.K.) It would be stimulating to find a new book on Matter, Ether, and Motion which contained a few new ideas—lead us a little way out of the beaten track into fresh fields of thought. Alas! it is still in the parched desert and the twilight that we follow Prof. Dolbear. Matter, for example, is defined as "whatever possesses the property of gravitative attraction." Now, the author adopts this definition in place of "whatever occupies space," but while he may gain a little as regards accuracy, the bewildered student is transferred as it were from solid earth to a base of operations situated somewhere near the centre of the universe. The migration is in the direction of that abstract mood in which Emerson may have been when a millenarian told him the world was coming to an end next day—"I can get along very well without it," said the philosopher.

Living Pictures. By Henry V. Hopwood. (Gutenberg Press, Ltd.) Illustrated. 2s. 6d. net. Here we have a complete compilation of the many facts which have led up to the production of so-called living pictures. From the fundamental persistence of vision, through colour tops, wheel phenomena and the photo revolver, to the various forms of camera now used and the treatment and production of films—all are gathered here in handy shape, and very useful digests of patents and an annotated bibliography give to the book features of permanent value. There are nearly three hundred illustrations, and a very complete index.

BOOKS RECEIVED.

Practical Exercises in Elementary Meteorology. By Robert De Courcy Ward. (Arnold.) Illustrated.

Unwin's Chap Book, 1899-1900. (Unwin.) Illustrated. 1s.

Letter-, Word-, and Mind-Blindness. By James Hinchelwood. (Lewis.) 3s.

Annual Report of the Board of Regents (Smithsonian Institution) for the year ending 30th June, 1897.

Life and Happiness. By Auguste Marrott. (Kegan Paul.) 2s. 6d. net.

British Dragonflies. By W. J. Lucas. (L. Upcott Gill.) Plates. 31s. 6d.

Discoveries and Inventions of the Nineteenth Century. By Robt. Routledge. (Routledge.) Illustrated. 7s. 6d.

Missionary Travels and Researches in South Africa. By David Livingstone. (Ward, Lock & Co.) Illustrated. 2s.

Journal of the Society of Comparative Legislation, December, 1899. (Murray.) 5s. net.

The Making of Europe. By Nemo. (Nelson.) 3s. 6d.

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The Grammar of Science. By Karl Pearson. Second edition. (A. & C. Black.) 7s. 6d.

Primeval Scenes. By the Rev. H. N. Hutchinson. (Lamley & Co.)

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Snow Goose in Ireland.—At the meeting of the British Ornithologists' Club, held on November 22, 1899, Dr. Bowdler Sharpe exhibited, on behalf of Mr. R. J. Ussher, a Snow Goose (Chen nivalis), shot near Belmullet, County Mayo. The specimen belonged to the larger form. Although the snow goose has been identified by competent observers we believe that it has never yet been obtained in England or Scotland. Several specimens have been shot before in Ireland, but according to Mr. Howard Saunders they all belonged to the smaller form. Both forms of the Snow Goose are inhabitants of North America.

Grasshopper Warbler in Morayshire. (*Annals of Scottish Natural History*, January, 1900, p. 48.) Mr. R. H. MacKessach has obtained nests and eggs, which have been identified by Mr. Harvie-Brown, of this species from near Elgin. This record seems to extend the northern breeding range of this bird in Great Britain.

Bee-eater in Shetland. (*Annals of Scottish Natural History*, January, 1900, p. 48.) A Bee-eater, which had been seen flying about at Symbister, was found dead by Mr. Arthur Adie on June 5th, 1899. The Bee-eater very rarely occurs in Scotland.

Pratincole near Montrose. (*Annals of Scottish Natural History*, January, 1900, p. 51.) Mr. J. A. Harvie-Brown records that Mr. Stormond shot a Pratincole at Rocksands, Montrose, on November 4th, 1899. The Pratincole has only once before been noticed in Scotland, viz., at Unst, Shetland, as far back as 1812.

Montagu's Harrier in Wicklow. (*Irish Naturalist*, January, 1900, p. 21.) Mr. Edward Williams records that an immature male of this species was shot near Kylebeg, Blessington, Co. Wicklow, on September 7th, 1899.

Rose-coloured Pastor in Co. Mayo. (*Irish Naturalist*, January, 1900, p. 22.) Mr. Robert Warren records that a female specimen of this erratic wanderer was shot near Foxford, on November 5th, 1899.

THE BURIED ALPS.

By Grenville A. J. Cole, M.R.I.A., F.G.S., Professor of Geology in the Royal College of Science for Ireland.

It is now well recognised that the granitic core of a great mountain-chain is not in itself the cause of the elevated highland. It has not forced itself up, splitting asunder the superincumbent strata, and hurling them back on either hand; but it bears in its own structure all the signs of stress and pressure, and has clearly been elevated with the strata, along some line of wrinkling in the crust. Here and there, remelting has gone on in the core, as the old rocks moved upward from Precambrian resting places; at other places fresh molten masses have intruded from some caldron far below. Along the axis of movement, the old crust has been squeezed together like a sponge; the liquids have escaped from one hollow to another, and at last consolidated as crystalline igneous rocks, destined to weather out in resisting peaks and pinnacles. The great arch, as it rose, became the natural receptacle for most of these flowing masses; hence, when denudation worked against the chain, these reconstructed types of the fundamental rocks—ancient gneisses that had renewed their youth, began to stand out prominently as a great central ridge. The stratified covering was swept from them, and is now found only in the foot-hills, where its very structure, consisting of folded layers, still renders it an easy prey. Rain and frost work in along the upturned bedding-planes; and the strained masses are always ready to slip and settle down before the earth tremors that still attack the chain.

The central core, then, marks out the axial character of the mountains; where, on the other hand, it has not been pushed sufficiently towards the surface, the features of the foot-hills may prevail from side to side of the wrinkled area. Thus it is that, as we approach the end of a chain, the scenery is less austere and more broken up into local landscapes—not so generalised as in the grander altitudes of the range.

This becomes markedly felt in the eastern borders of the Alps, where the hills ramify like huge fingers, grasping between them the inlets of the European plain. At times we scarcely realise the presence of the massif, the potential mountain-range, though all the time it lies buried at no great depth beneath us.

We leave Vienna by the Cainozoic ridge of Schonbrunn, and are practically entering, from a geographical point of view, on the great Karpathian ring, which girds about the whole of Hungary. On our right, the green but broken highland, covered with its woods, represents alike the limestone Alps of Innsbruck and the forest-ranges of the Tatra which dominate, far in the north-east, the hamlets of the Polish plain. Similarly, the gneissic axis south of us, peeping out along the Leitha Hills, forms the neck that unites the Hohe Tauern of Salzburg with the mining district of Hungary, and, farther still, with the wall-like frontier of Roumania.

There is little, however, to suggest the Alps or the Karpathians in the gentle slopes above the Leitha. The ground rises, that is all; and the first dusty levels of Hungary, where the great white cattle feed in unbounded fields, pass into a more tumbled country, shaded here and there by trees. The villages occupy the strategic positions on this miniature mountain side, with an occasional ruined tower, holding a pass some 600 feet above the sea. Then we descend into the yellow dust again, with the grey waters of the Ferto Lake (Neusiedler See), filling its basin on the left. Even this lake emphasises the contrast with the Alps; it is ten miles long and about four feet deep, saline itself, and bordered by still salter marshes. This is clearly a feature of the plain, into which it often merges by evaporation.

Continuing southward, we actually touch the gneiss on a little rise beyond Sopron (Odenburg); and we get under a real hill at Koszeg, the last spur of the north-eastern Alps. Then, for kilometre after kilometre, we cross a low plateau, formed of crumbling Pliocene and Miocene strata, among which are the last marine deposits laid down in Eastern Europe. Every now and then, we descend into an alluvial flat, cross some stream running eastward to the Danube, note the villages clustered thirstily along it, and push up again to the yellow scarp of the plateau.

But in time the alluvium becomes the prevailing feature. At Baksa, the country is so level that a tall pole, with cross pieces nailed to it, is set up in the village, so that the watchman can ascertain the locality of a fire, when roused by the glow against the sky. The brown acres are ploughed from the roadside to the horizon, and the farmer can view his twenty-two pairs of oxen moving, at wide intervals, across one even field (Fig. 1). The little towns exist purely for the cultiva-

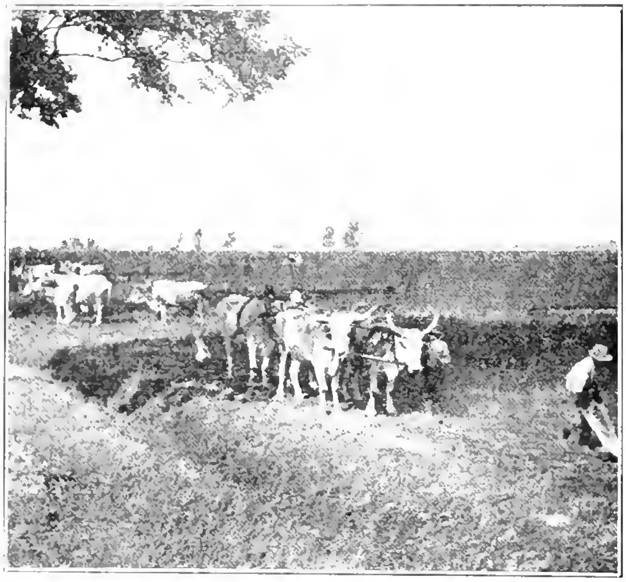


FIG. 1. Ploughing in the Plain of Western Hungary.

tors of the soil, and a market-day clears the country round. In the afternoon, however, the peasants will stream out again, hundreds of swaying rustic carts will follow one another down the road; and the clear gold sunset, a veritable sunset of the plains, will add its colour to the crimson and blue and orange of the dresses of sober matrons, or to the white kerchiefs of bronzed and laughing girls.

We are, in fact, approaching the first of the great Alpine rivers; for at Lendva we enter on a valley, which varies from 7 to 16 kilometres (10 miles) in width—a valley choked with sand and pebbles, spread out by successive shiftings of the stream. Against the southern bank, which is at present favoured, the Mur runs among its sandy shoals. Here, in the middle of a continent, the river already lies only 160 metres above the sea; and it shortly lets its waters slip, as if exhausted, into the greater current of the Drava.

How should we know this river, this lowland Mur, for that which we have seen in flood through Styria, tearing at its banks, washing away roads and houses, rejoicing to run its course among the shattered forests of the Alps? Or is it the same that flows at its birth through all those resonant ravines, as we come down from the crags of the Tauern, where the chill clouds move against the walls of rock, and feed each night the growing streamlets in the clefts? Truly, the rivers depend for their life upon the mountains; and they are always undoing themselves, wearing away their gathering-grounds, and choking up their own courses in the lower reaches of their valleys.

There is quite a ridge, comparatively speaking, between the Mur and the Drava. In this level country it is an incident in itself, hough the summit lies about as high as Richmond Hill above the Thames. Beyond it is the flat in which the Drava wanders. Here we have a river indeed, with a long course yet before it; but it divides already into a number of loops and backwaters, and all attempts to use it as a boundary between Hungary and Croatia have failed. You may see upon a detailed map how the official frontier curves this way and that, representing, no doubt, some ancient windings of the stream; but new routes are always opening among the alluvial islets, and a fringe a kilometre wide on either hand is abandoned to the chances of the floods. The river, in its numerous channels, flows silently between banks of grey-green willows, which hide the water until we are close upon it. At last we find the main artery, spanned by a long iron bridge; we are now again only 160 metres above the sea, which lies at Varna, as the crow flies, 600 miles away.

The Drava, traced back as the German Drau, has done its work at higher levels. It rises at a height of 1300 metres among the stone-slides and fir-woods of the dolomites of Toblach; we may follow it, reinforced by noisy brooks, through the flood-swept gorge of Lienz, one of the most impressive scenes of rock-destruction to be found in the whole of Europe; we may see it swirling the timber- rafts upon its bosom through the ravine of Sachsenburg, and then emerging, with an air of innocence, among the maize-fields and farmsteads of Paternion. Soon, where the clear green Gail flows into it, we hear of it as the Drava, in the soft and grave Slavonic speech. It cuts its way for another eighty kilometres to Marburg in Styria, often lying deep between vertical walls of rock; and then ultimately it becomes wearied, and covers the country to Varasdin and the Danube with the spoils of Karinthia and Tyrol.

In fact, these great eastward-flowing rivers have worn their way down practically as far as they can, and have reached almost the same levels in the plain; and now, as their flow becomes more sluggish, they may even tend to raise themselves on their own alluvium, instead of cutting out a groove in it. Their history has been much the same; doubtless they began to flow when the Alps at first arose; and they may thus have fallen at one time into the late Miocene sea of eastern Europe. Soon, however, this sea was banked out by continued uplift of the land; brackish and fresh-water lakes replaced it in the west of Hungary; and then these also disappeared, their floors being raised against the cutting action of the streams. A number of shallow valleys have now been excavated, and the rivers from the Alps, with the spread of the continent, have grown longer and longer towards the east. The removal of matter from Styria and Karinthia to the plains has been going on since early Pliocene times. The pebble-beds that we have traversed on the plateaux contain all manner of old rocks, quartzite and schist and gneiss, clearly deriv d from the central portions of the chain; and all this detritus has filled up pre-existing hollows, and has buried deeper than ever the unseen prolongations of the Alps.

If, however, the invisible ridges below us continue to rise, the period of deposition may pass away. But are upward movements in progress, or is merely settlement going on? In Switzerland, the conversion of long mountain-valleys into lakes, such as those of Lucerne and Como, points already to a sinking of the central massif. But this indication of old age is absent in the younger ranges to the east; and Switzerland was already high and dry when Italy and parts of Austria-Hungary lay still beneath a Cainozoic sea. Hence elevation may still be going on in the east, and the buried Alps may be destined to play their part in Europe.

The frequency of earthquakes in the area under consideration shows at least a condition of unrest. In Agram, the Croatian capital, shocks are felt about twice a year; and the city was in great part destroyed on November 9th, 1880. Still more recent examples are the Bosnian earthquake of 1891; the great Servian shocks in 1893; the destructive earthquake of Laibach on April 14th, 1895, when twenty-five shocks were felt, and when tremors were noted at Vienna and Trieste, at Salzburg, and at Agram in the east. In 1897, Laibach was visited by a smaller, but also destructive, earthquake; and a complete series of observatories would probably reveal, as Dr. C. Davison has remarked, the extreme instability of the region that stretches from Karinthia to Constantinople.

At present, the alluvial features of the Drava Valley give Verasdin the appearance of a city in a plain. But in the south a long range of wooded hills can be descried, a welcome change from the bare Hungarian levels. These broken ridges, in parts as lofty as the Grampians, lie in the direct line of the Carnic Alps of Tyrol and Venetia. Now and again, as we cross them, a little scarp of grey limestone among the trees serves as a reminder of the superb rock-giants that gather on the wall of Italy. But the peaks of Cortina and the canons of Auronzo are remote indeed from this warm and cultivated upland. The clustered woods give way to parks and farmlands; there is one more pass, with a show of romantic interest, whereby we rise to 208 metres, or not quite 700 feet above the sea; and then we have a long fall to the valley of the Sava, and the crossing of the Alps is an accomplished fact. In a traverse of some forty miles, we have ascended, as it were, to the level of the Surrey Downs, and have completed our passage of one of the structural lines of Europe.

The diversity of rocks, however, in this model of the Alps, has given us a corresponding change of scenery; and the noble Sliemen range above Agram in no way disappoints the eye. Even the crystalline schists of the core crop out at the north-east end of it, flanked by little patches of Cretaceous limestone, such as are uptilted in Switzerland to form heroic crags. It is evening as we come down into Agram, in the shadow of these steep grey hills; and far away in the west we can see the huge ridges of the limestone Alps themselves, a vision of purple and pale gold, against the lurid glory of the sunset.

Next morning we cross the Sava, on a long bridge that seems to lead into a limitless expanse of level cultivated land. The river flows through its own brown alluvium, a mere magnification of the Raba, or the Leitha, or other streams that open out on the fringe of the Hungarian plain. Once in a while a hamlet, or one of the old eastern wells, provides an incident for the eye; elsewhere we move between the maize-crops, their stems seven or eight feet high, effectually walling in the road. Sometimes in the open, we see the clouds gathering on the fine mass of the Sliemen, and the towers of Agram falling back behind us in the shade. And yet this Sava has also had its day of strength and energy. For it rises in a wild and craggy highland, close against the valley of the Gail; the limestone fortress of the Mangart guards it from the southern sun; and the great grey blocks, split by frost from the wall of Italy, form the first boulders in its stream. A straight line from its source to Agram, where it leaves the highlands, measures two hundred kilometres, or more than one hundred and twenty miles.

Through southern Croatia, the villages are artificially protected from floods, and the roads along the rivers run upon embankment. The same precautions, often futile, have to be taken here, as in the Danube plain itself. The bends of the river are thus, through artificial aid, a little more stable than they were in former times, and strenuous efforts are made to keep the water within bounds. Beyond Sisek, the old loops and backwaters become more frequent, and strangely curved villages diversify the scene, their form having been originally dictated by bends of the river which has deserted them. Elsewhere, the houses cluster along the first terrace of the hills, their bases washed by the alluvium, as by a sea; the great highway of the "military frontier" runs towards Turkey on the outcrop of the Pliocene strata, and the villages have grown out along it from north-west to south-east, until some of them stretch for five kilometres along the road. The great flat between them and the river is given over to marsh-land and oak forest (Fig. 2); and the country has a poor and desolate air, much as if it were still swept by the Turkish irregulars of a hundred years ago. The only offshoots of these elongated villages lie in the tiny valleys of the lateral streams, where huts piled indiscriminately, and half hidden in the trees, climb up along convenient watercourses.

FIG. 2. In the Oak-Forest of Vukovina, alluvium of the Sava.

When, at any point, we have to cross the alluvial plain, we may feel at once the shelterless nature of the country. All the morning, the storm has been creeping nearer. The black gloom that gathered in the Agram hills has blotted out the distance with terrific and truly inky thunder-clouds. As we turn round, kilometre after kilometre, we can feel the sunlight being swept from the face of heaven; the earth lies still; even the great oak-forest, from which we have emerged, is only just beginning to tremble in its topmost leaves. But now the first wind touches it, the first drops begin to fall; the whole life of the country is at once in motion, fleeing along the road where the dust is whirled up strangely amid the rain. Hailstones descend, at least an inch across, and break themselves to pieces on the ground. Horses, cows, poultry, white-kerchiefed girls, and men in black coats, their sleeves flying out behind them, hurry into the nearest villages from the blank and broken fields. Up in the Alps you may crouch beneath a rock and see the lightning leap from scar to scar, and hear the church bells ringing out their answer from the fields a thousand feet below: but here, in the great open, the elemental forces will hold you more securely in their grasp. A hand, as it were, at first gentle, then imperious, pushes you forward from behind. In the air there are resistless spirits; in the oak-forest there are strange whisperings, and the cry of frightened birds. The herd-boy, with his rustic pipe, knows these things better than the wisest student of geography.

LONG WAVES OF WINTER WEATHER.

By ALEX. B. MACDOWALL, M.A.

THE student of weather uses various time-units; hours, days, months, seasons, years, &c. Each of these is a grouping of smaller units; and proceeding further, he may compare groups of five years, or ten years, or more. This is often instructive; and it is still better, in the case of a given year-group, to compare, not merely successive groups of that order, but overlapping groups, e.g., in the case of ten-year groups, not merely 1841-50, 1851-60, etc., but 1841-50, 1842-51, 1843-52, etc. Here we come to the principle on which curves are often smoothed. Instead of observing how a given element varies from year to year, we note how the average of three, of five, of ten years (or more) varies from year to year. (The principle obviously applies to smaller units also.)

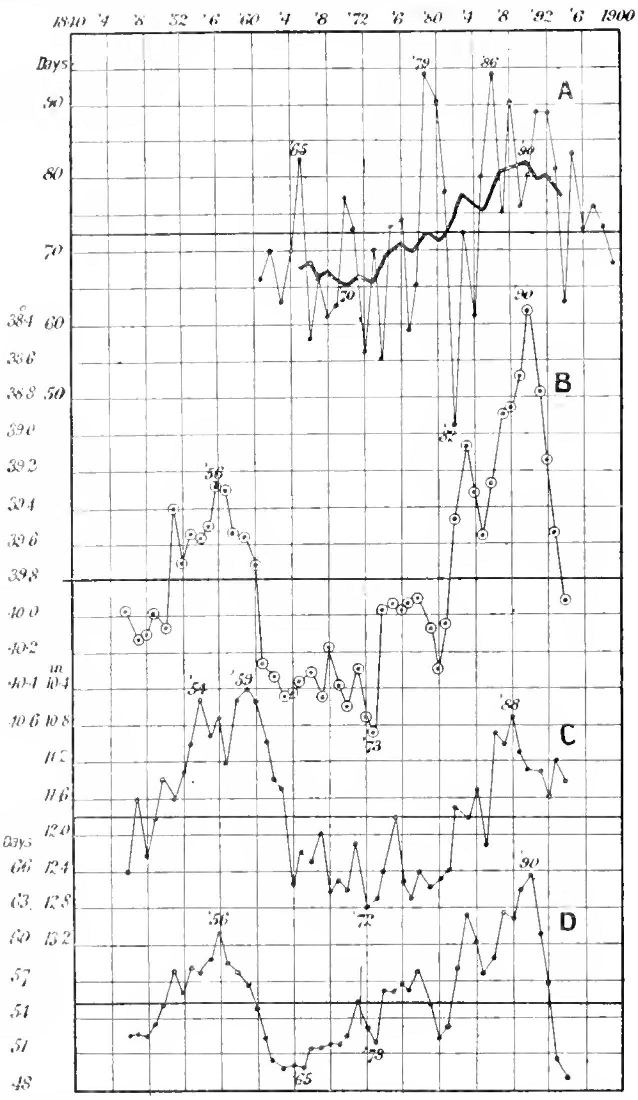
Some interesting relations are thus brought out; and light may be thrown on those longer waves of variation, which often underlie, and are rather obscured by the minor undulations.

In this paper, I propose to look at winters in groups of ten. The term "winter" will be used somewhat loosely, and winters may be briefly denoted by the year in which they end (1842, e.g., meaning 1841-42).

Let us begin with wind in the winter-half (October to March). Taking the Greenwich tables of wind-distribution in which all winds are reduced to the four cardinal directions, we may ask, How many days of northerly and easterly wind (the two colder directions in winter), occurred in each of the winters from 1860? The reply appears in the zigzag curve A. This is traversed by a thick line curve, each year-point of which represents an average of ten; e.g., the first, 1865, the average of 1861-70; the second in 1866, that of 1862-71, and so on. This average, it will be seen, rises on the whole, from a minimum in 1870 to a high point in 1890. That is to say, in the ten winters about 1870, little N. and E. wind; in those about 1890, much.

Next, as to temperature. B is a curve derived from that of the mean temperature of the group of four months December to March, since 1842, by the same averaging process. It is an inverted curve; the high points meaning low temperatures, and the low ones high. Here we find two conspicuous wave crests 1856 and 1890, while a minimum (maximum of mildness) appears at 1873.

Thirdly, rainfall. In the coldest parts of the year, severe cold and dryness are generally associated, while great mildness often goes with wetness. Treating the rainfall of October to March in the same way, we get the (inverted) curve C; and it is not surprising to find a general similarity to that of temperature. The ten-winter groups about 1856 and 1890 ('88 the highest point), show a deficiency of rainfall; those about '73 ('72) an excess.



A. Days of N. + E. wind in October-March (Gr.), smoothed with averages of 10. B. Mean T. (Gr.) in December-March, smoothed. C. Rainfall, October-March (Gr.), smoothed. D. Frost days, September-May (Gr.), smoothed. B and C are inverted.

Lastly, frost days in September to May. The curve D, obtained in the same way, agrees with B in its maxima (of cold) at '56 and '90; but the dip between reaches its lowest point a little earlier, in '63 or '65.

We have, then, the outstanding fact, of a great peak, or wave crest, of cold about 1890; the ten-winter group 1886-95, being the coldest of all the 49 groups considered. That group is also conspicuous for its quantity of N. and E. wind, and shows less than the average precipitation. It may be useful to look at those ten winters, from the standpoint of frost days. The average in September to May being about 55, we have the following numbers and relations:—

	'86.	'87.	'88.	'89.	'90.	'91.	'92.	'93.	'94.	'95.
Frost days ...	75	80	90	60	45	82	73	48	42	62
Relation to average	+20	+25	+35	+5	−10	+27	+18	−7	−13	+7

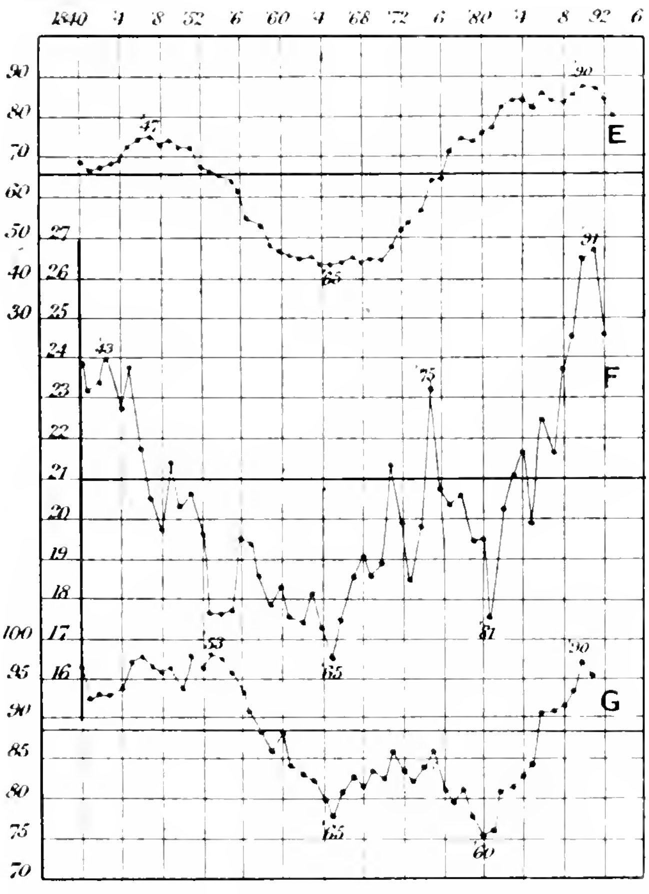
Thus we see that seven out of those ten winters were severe; that 1888 had the largest number of frost days; and that 1890 itself was one of the three mild winters. Those ten winters show a total of 657 frost days, being 107 over the average.

In the ten-winter group about 1856, seven out of the ten were also severe; but the total excess was only 60. At the minimum '73, we find six winters mild and four severe (total deficiency 28).

This pronounced peak of cold (about 1890), how is it to be accounted for? Speculation seems vain, till we know more about ocean currents, cosmic influences, and other things.

Then, there is the other crest of the curve in 1856; and we may note the fact, that its distance from 1890 is just 34 years, reminding us of Bruckner's period, with an average of 35 years.

Once more, we find that in the sixties and seventies, the cold of those ten-winter groups is generally slight, while the N. and E. wind gives way to more genial currents, and rain is abundant. A prevalence of northerly wind, it may be noted, probably corresponds with frequent areas of high pressure in the west of these islands, and a prevalence of easterly winds, with high pressure systems in the north (the circulation in such areas, in our hemisphere, being with the hands of a watch). Many interesting points in the behaviour of such systems have been lately brought out by Van Bebber.



E. Frost days in heart of France, smoothed. F. Very cold days, Geneva, smoothed. G. Frost days, Geneva, smoothed.

It may be interesting if we turn for a moment to look at the state of things on the Continent. E is the curve derived from that of frost days in the heart of France (Parc de Baleine), and G the same for Geneva (with different scale); while F represents very cold days at Geneva; days, viz., in which the thermometer did not rise beyond freezing point. All three are obtained in the same way as before, each point representing the average of ten years. These curves all show a long trough between two high crests, as before; the later waves in each case culminating about 1890 or 1891, as in London; but the earlier waves are somewhat earlier than in the London curves. Further details may be left for the consideration of the reader.

Reverting to the London curves, do they throw any light on the future?

If we take the curve B as roughly representing Bruckner's period of 35 years, and accept his evidence showing that this period may be traced back in one way or another through about two centuries at least, we might perhaps reasonably look for some kind of repetition of the descent from 1856 to 1873 (i.e., 17 years), bringing us to a minimum about 1907; this being followed by a general rise to another maximum about 1924.

We are evidently now in a period of declining cold; and the decline in those averages has, so far, been rapid. We can hardly suppose this decline will be continuous (i.e., without temporary rise) to the supposed minimum, nor is it likely to be so rapid as it has been since 1890; and in any case it would be difficult to fix, in advance, with much precision, the character of the individual winters covered by it. But at least it seems probable that, for a good many years to come, we shall not be visited with such an accumulation of cold as that in the ten years about 1890.

Microscopy.

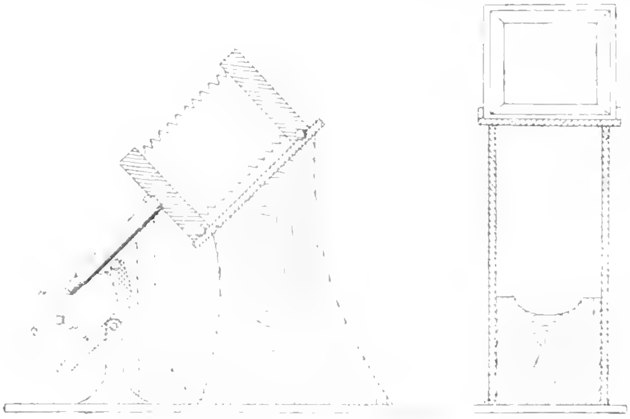
By John H. Cooke, F.L.S., F.G.S.

Micro-photography is now used by microscopists so extensively for educational, medical, and other professional purposes, that we propose to incorporate in these columns notes on new apparatus and methods dealing with this branch of microscopy. We shall therefore be pleased to hear from readers interested in the subject, and shall be glad to receive from them notes of any improvised laboratory, apparatus, or devices in manipulation that they may have adopted. Such apparatus and devices are frequently of real practical value, but being, perhaps, obviously simple to their originator, it does not occur to him that they may be of use to his fellow-workers.

Micro-photography is one of the simplest and best methods known for making permanent records of microscopic studies. It is not, however, so universally used as it should be, and this, not so much for the few difficulties that it offers, as on account of the mistaken ideas as to the cost of the apparatus required. Good work may be done by a patient and skilful manipulator with an ordinary camera, or any other makeshift arrangement; but such good work would, in all probability, be rendered still more valuable by the use of apparatus specially designed for the work. The question of cost can no longer be considered seriously as an obstacle to its practice.

There are now several makers who are prepared to sell well made cameras for photo-micrographic work at prices considerably less than the cost of an ordinary camera. Messrs. Griffiths, Highgate Square, Birmingham, have a particularly good apparatus, consisting of a well-made bellows camera, extending from twelve to thirty inches, and attached to a [illegible] base, carrying camera, microscope, and condensers. The object is readily focussed in any position by means of a long, adjustable brass rod which is attached to, and runs the whole length of the camera, and which is connected with the milled head of the fine adjustment screw of the microscope by means of a silk thread passing over a grooved wheel at the end of the rod. It is made in half-plate size with carriers for smaller-sized plates, and its price places it within the reach of all.

The photography of living bacteria and other cultures cannot be successfully accomplished with a horizontal camera. The use of an upright apparatus is the best, but it is open to many objections, chief among which are its instability, the difficulty of focussing, and the fatigue it occasions the operator. Mr. Brightman, Colston Street, Bristol, has devised a useful and substantial support (see Fig.), which overcomes these difficulties,



Side Elevation. *Back View.*

and enables the photographer to successfully operate with his apparatus at an angle of 45° to the vertical. The arrangement is a good one, and is already in use in medical circles in Bristol.

One important habit which the microscopist should cultivate is that of making copious notes of observations. He should never be without his memorandum or note book. No more profitless work can be imagined than collecting natural history specimens and material without some specific aim or object. Every observation made should be carefully recorded, and the date of capture, locality, and, where possible, the food-plant, should always be attached to the specimens when these are mounted. For field memoranda the use of a stylographic pen is advisable, as pencil writing is apt to rub and efface in time by the motions of the body. A larger record book for more extended notes should be kept at home for biological details. When studying insects, for instance, notes on adolescent states, which it is intended to rear to the imago, cannot be too carefully made, or in too much detail. The relative size, details of ornamentation and structure, dates of transformation from one state to another — indeed everything that pertains to the biography of the species—should be noted down, for where exact data are so essential, little or nothing should be trusted to mere memory.

In photographing wood sections without a lens, Herr Fomm places a piece of tinfoil on one side of the section and the film surface of a piece of bromide paper against the other side. A good impression—showing clearly the rings and rays of the wood—is produced in about a half a minute when a metallic point negatively charged by an influence machine is brought within two inches of the paper. It is explained that the paper becomes negatively charged, and a photographically active glow-light is produced between it and the wood. It is proposed to try this method for copying drawings and for other purposes.

Mr. F. R. Rowley gives some valuable hints on the collection and preservation of diatoms in a recent issue of *Natural Science*. In collecting, a spoon attached to a stick may be used for skimming the brown diatomaceous ooze off the surface of the mud ; a drag net serves this purpose in the case of forms occurring at greater depths, e.g., *Surirella*. The latter should be placed with water in shallow glass vessels sheltered from direct sunlight. The diatoms will appear in masses on the surface of the mud after twelve hours. Transfer them by means of a pipette to the fixing fluid. Fleming's chromo-aceto-osmic acid, and sublimate, in aqueous or alcoholic solution, is recommended as being the best reagent for demonstrating the delicate structural features of the nucleus and cytoplasm during division. The chromatic elements of the nucleus are well shown by picro-sulphuric acid followed by hæmatoxylin. The arrangement of the cytoplasm, the chromatophores, and other inclusions in the cell may be well brought out, in unstained preparations, by a one per cent. osmic acid solution. A solution of iodic alcohol (45 per cent.) is recommended for the study of the so-called "red granules" of Bütschli, which, by the foregoing method, stain well after fixing.

Large forms receive a somewhat different treatment. They are removed individually with the aid of a capillary tube and a dissecting microscope, and are transferred to the fixing bath. The solution is decanted off after fifteen minutes and the objects are passed through water and alcohol, of strengths increasing to the absolute point. This extracts oil and the colouring matter of the chromatophores. The preparation is then passed through alcohols of decreasing strength into distilled water, after which it is stained in a weak solution of Delafield's hæmatoxylin. The material is then passed successively through 35, 70, 95 per cent. and absolute alcohol into clove oil and finally mounted in dammar.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* KNOWLEDGE.]

NOTES ON COMETS AND METEORS.

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

No new comet has been discovered during the last three months. Giacobini's comet (first seen on September 29th, 1899) is now invisible, and Holmes's comet some time since passed beyond the range of ordinary instruments. An ephemeris by Zwiers is given in *Ast. Nach.* 3610, and from this it appears that the position of Holmes's comet on February 5th, 1900, will be R.A. 2h. 40m. 40s., Dec. + 39° 14′ 37″, or about 5 degrees west of β Persei (Algol).

Finlay's Comet.—This object was discovered in September, 1886, at the Cape of Good Hope, and it was soon found to be moving in an elliptical orbit, with a period of little more than six and a-half years. Mr. Finlay redetected the comet in July 1893, and it is now again near its perihelion, but M. Schulhof, of Paris, has recently investigated the orbit, and finds that the comet is not likely to be seen before 1906. In August of that year it will be comparatively near to the earth, the distance separating the two bodies being less than 20 millions of miles.

The Shower of Leonids in 1899.—The comparative deficiency of meteors at the middle of last November has led to the suggestion that the position of the stream may possibly have been disturbed by planetary attraction. Though this particular shower has been irregularly providing us with brilliant displays during the last thousand years, there is certainly evidence to show that the meteor-group has been sufficiently disturbed to enable it to pass almost clear of the earth. From computations undertaken by Dr. Downing and his assistants at the *Nautical Almanac* Office, it appears that the large planets Jupiter and Saturn have exercised considerable influence upon the orbit of the swarm which visited us in 1866, and that at its return in 1889 it must have passed about 1,300,000 miles inside the earth's orbit. Next year the conditions will be still more unfavourable, whence, if the theoretical deductions are quite reliable, there will be a poor display, unless the meteors are richly dispersed in a direction away from the sun. Indeed, the opinion seems gaining ground that the shower is practically lost to the present generation of observers. There is, however, sufficient doubt in the matter to encourage the hope that the meteors may reveal themselves either in 1900 or 1901, and particularly in the latter year. There was a fine display in 1868, though it was little expected. We have perhaps, in recent years, regarded our prospects of witnessing a bright reappearance of the phenomenon in too favourable a light, when all the circumstances are considered. At a single station the chances are always great that the shower will escape observation. During the last thousand years very few brilliant returns have been observed in England. Historical records do not furnish descriptions of showers in 1833, 1799, 1766, 1733, or in many previous years when the Leonid comet was probably near its perihelion. Had the event occurred some mention of it would certainly have been preserved. But notwithstanding prevalent doubts, and the failure of recent attempts, we should redouble our efforts to witness the shower in the two or three ensuing years, for even should it fail to present a conspicuous aspect, it will be possible to obtain negative evidence of a useful kind. It must be remembered that displays took place in 902, 1002, 1101, 1202 and 1602, so that we need not despair of seeing the meteors until after the return of 1902, for exactly three periodical revolutions of the meteor group are completed in a century.

Bright Meteor of November 19, 1899.—At 8h. 5½m. a meteor, equal to Jupiter in apparent lustre, was seen by Mr. T. W. Backhouse at Sunderland, and by Mr. C. L. Brook at Meltham, near Huddersfield. It moved slowly and was yellowish white in colour. The paths indicate a radiant at 60° + 28° on the northern boundary of Taurus, near the star Psi. At its first appearance the meteor was about 85 miles high, over a point in the sea 40 miles east of Hornsea, on the Yorkshire coast. When it disappeared it was 42 miles over Driffield, and had completed a path of 68 miles in three seconds.

Fireball visible in Sunshine, January 9, 1900.—At 2h. 55m. p.m. on January 9 last, when the sun was shining brightly in a cloudless sky, a fireball of remarkable size and lustre was seen at many places in England. Descriptions of its appearance have been received from Brighton, Eastbourne, Lewes, and Worthing (Sussex), Penshurst and Beckenham (Kent), Guildford and Reigate (Surrey), and other places. All the observations come from the S.E. region of England. A preliminary reduction of the materials indicates that the radiant was situated between Aquila and Sagittarius, and that the fireball descended from 59 to 27 miles during its flight of about 140 miles over the English Channel. Its motion was very rapid, and the general direction of its observed course from S.W. to N.E. This phenomenon reminds us of the large meteor which passed over Lancashire and Yorkshire on February 8, 1894, at 28 minutes after noon.

The Meteors of Biela's Comet.—In our last month's "Notes" it was mentioned that the astronomers of the Vienna Observatory counted 67 meteors, most of which were from Andromeda, on the evening of November 23rd. From a communication in *Ast. Nach.* 3612, it appears that observations were continued on November 24th, when 240 meteors were seen in the five hours ending 10h. 30m. The maximum occurred at 8h., when the horary rate of apparition was about 80.

The January Quadrantids.—Prof. A. S. Herschel, of Slough, obtained a very successful observation of these meteors on the night following January 2nd, 1900. Between 11h. and 16½h. he saw 130 meteors, and registered the paths of 80 of them. The Quadrantids furnished about four-fifths of the total number seen. During the night two very fine meteors were recorded as follows:—

Time 14h. 58m., Mag. 3 × ♀, Path 95° + 50° to 87° + 38°.
„ 16h. 17m., „ = ♀, „ 35° + 52° to 45° + 40°.

Mr. W. E. Besley, of Clapham Common, S.W., also watched the progress of this shower on January 2nd. Between 11h. 38m. and 13h. he counted about thirty meteors, and nearly half of these were Quadrantids, with a radiant at 230° + 54°. At 11h. 59m. he registered a 1st magnitude meteor, which was also seen by Prof. Herschel at Slough. From a projection of the combined paths the radiant comes out at 228° + 53°, so that it was a true Quadrantid. The meteor fell from 57 to 40 miles, and had a length of path of about 44 miles, which it traversed in 2 seconds.

THE FACE OF THE SKY FOR FEBRUARY.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 7.41 and sets at 4.47; on the 28th he rises at 6.50 and sets at 5.36. Few sun spots are likely to be observed. Observers interested in the Zodiacal Light should keep a watch for it in the west during the early evenings.

The Moon.—The moon will enter first quarter at 4.23 p.m. on the 6th, will be full at 1.50 p.m. on the 14th, and will enter last quarter at 4.44 p.m. on the 22nd. There is no new moon this month, according to the ordinary civil reckoning. Kappa Piscium, mag. 5.0, will be occulted on the 2nd; disappearance at 6.56 p.m. at 101° from the north point (65° from the vertex), reappearance at 7.43 p.m. at 210° from the north point (172° from the vertex). Delta Arietis, mag. 4.5, will be occulted on the 6th; disappearance at 8.36 p.m. at 127° from the north point (93° from the vertex), reappearance at 9.21 p.m. at 211° from the north point (175° from the vertex).

The Planets.—Mercury will be in superior conjunction with the sun at 9 p.m. on the 9th, and will afterwards be an evening star. Towards the end of the month he will come into a favourable position for observation, setting on the 28th an hour and twenty-three minutes after the sun. He will then be in the south-western part of Pisces, away from bright stars, at 6.30 p.m. he will be about 8 degrees above the horizon and 6 degrees south of west.

Venus is an evening star, and will be a striking object in the western sky after sunset. At the middle of the month the planet crosses the equator and will then set about 8.30 p.m., eight-tenths of the disc being illuminated. The planet enters Pisces in the early part of the month and approaches the eastern part of that constellation towards the end.

Mars is too near the sun for observation.

Jupiter is a brilliant object in the morning sky. On the 23rd, at 4 a.m., he is in conjunction with the moon, and 1° 31min. to the north, the moon then being at nearly half phase. He is in quadrature with the sun at 6 p.m. on the 28th. About the middle of the month he rises shortly before 3 a.m. During the month he describes a short direct path in the most southerly part of Ophiuchus.

Saturn is also a morning star, rising on the 14th at about 4.37 a.m. During the month he describes a short direct path in the western part of Sagittarius.

Uranus is also a morning star, rising at the middle of the month about 3.6 a.m. He is in the southern part of Ophiuchus, nearly midway between Antares and Eta Ophiuchi and about 4° east of Jupiter at the middle of the month.

Neptune is an evening star, setting at the middle of the month about midnight. His path is a short westerly one through the Milky Way in Taurus; at the middle of the month he is 1° north of Zeta Tauri and three-quarters of a degree following that star.

The Stars.—About 9 p.m., at the middle of the month, Ursa Major will be in the north-east, Arcturus rising in the north-east, Leo will be a little south of east, Cancer and Hydra in the south-east, Gemini and Auriga nearly overhead, Canis Minor and Canis Major near the meridian, Orion a little west of south, Taurus in the south-west, Aries and Perseus in the west, and Andromeda and Cassiopeia towards the north-west.

Convenient minima of Algol will occur at 10.57 p.m. on the 13th, and 7.46 p.m. on the 16th.

Chess Column.

By C. D. Locock, B.A.

Communications to this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions for January Problems.

(J. T. Blakemore.)

No. 1.

1. Q to KB2, and mates next move.

[There is unfortunately another solution by 1.

Q to KKt6, this in fact being the solution discovered by almost all our correspondents.]

No. 2

1. Q × P, and mates next move.

CORRECT SOLUTIONS of both problems received from E. Servante, Capt. Forde, Alpha, W. de P. Crousaz, G. C. (Teddington), J. W. Meyjes, W. J. Allen (both keys), H. Le Jeune, H. S. Brandreth, K. W. J. Baddeley.

BERNARD LINTON. December solutions received too late to acknowledge. No. 1 is incorrect, as you may have seen.

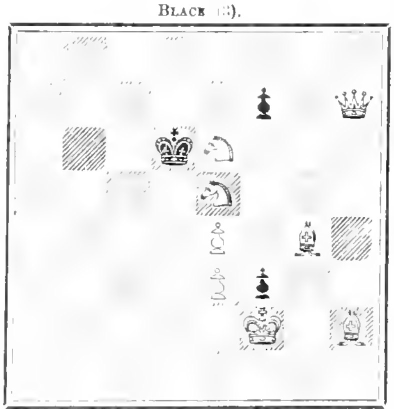
J. BADDELEY.—Nevertheless the solver, as you say, "has only himself to please"; and as it is better to read Homer with a translation, than not at all, so the solver who cannot master a problem from the diagram is justified in moving about the pieces. The question in fact must apparently depend on the solver's ability.

We revive below two ancient Problems well worthy of resurrection. Our solvers will not have such an easy time as they have had for the last two months.

PROBLEMS.

No. 1.

BLACK (3).

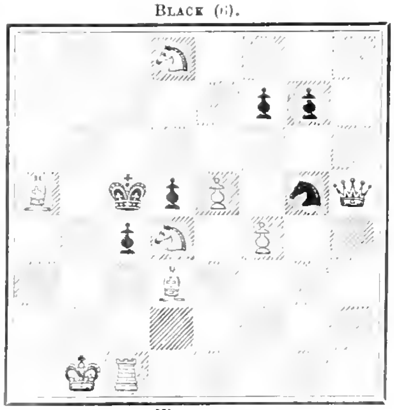


WHITE (8).

White mates in three moves.

No. 2.

BLACK (6).



WHITE (9).

White mates in three moves.

Both the above are by the late J. G. Campbell, one of the strongest players, as well as one of the ablest composers of the last generation.

CHESS INTELLIGENCE.

The Austro-Hungarian National Tournament at Vienna the prizes for which were bequeathed by the late Baron Kolisch, resulted in a victory for Geza Maroczy, who scored 9 games out of 11. The second and third prizes were divided between C. Schlechter and a new player named Brody. Alapin took the fourth prize, the other scores being Marco, Wolff, and Zinke 6, Kolve, 5, Popiel, 4½, Albin, 4, Schwarz and Prock bringing up the rear. It is unfortunate that ill health prevented Charousek from competing. The next international tournament begins at Paris on May 15. The prize fund already amounts to 16,000 francs.

On January 13 Kent County gained a handsome victory over Hampshire by 11½ games to 4½, the match being in the first round of the Southern Counties' Chess Union Championship. This result points to a most gratifying improvement in the play of the Kentish team. Mr. Hart-Dyke defeated Mr. J. H. Blake at board No. 1.

At the City of London Chess Club, Mr. Lawrence still retains a strong lead with 8½ out of a possible 9. Mr. W. Ward has scored 8 out of 10, and Mr. Herbert Jacobs 7 out of 9. The remainder are beginning to tail off.

The death is announced of Dr. Max Lange, the well-known player and theoretician, at the age of 67. His name will always be remembered in connection with the Max Lange variation of the Guioco Piano opening.

The Northern Counties Chess Union has issued its new programme, which contains, among other items, a challenge to the Southern Union to a match by correspondence with 50 players aside, and a congress to be held in Manchester on Easter Monday.

A National Chess Union is also in process of formation, with the object of filling the place of the old British Chess Association, which has practically been defunct for many years.

The following has been sent to us for publication:—

TO THE CHESS EDITOR.

DEAR SIR,—We shall be extremely obliged if you will kindly announce to the readers of your Chess Column that we are distributing Copies of the Wall Sheet "Laws for the Regulation of Games played over the Board," being Part II. of the British Chess Code (Revised Edition). These are intended for use in Chess Clubs, Reading Rooms, Chess Resorts, &c. Should any any of your Readers desire this Wall Sheet, they are requested to send the Address of Club or Room in which Chess is played to the British Chess Company, Stroud, Glos., and a Copy will be sent without charge.

Yours faithfully,
THE BRITISH CHESS CO.

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THE COMING ECLIPSE OF THE SUN.

By E. Walter Maunder, F.R.A.S.

The great success which attended the expeditions that went out to watch the Indian Eclipse of 1898, will, it is to be hoped, have quickened the interest in eclipse work, and will lead to that of the coming May being observed yet more thoroughly. Political events have drawn attention into other directions, but it is so seldom that so good an opportunity is afforded to the inhabitants of these Islands to observe an eclipse with so little or so easy travelling, that it would be a great misfortune if the occasion were not utilized to the utmost.

The path of the eclipse is as follows:—It begins on the Pacific Coast of Mexico, where the eclipse begins at sunrise; the shadow track crosses the north-west angle of the Gulf of Mexico, and strikes the United States in Louisiana. Travelling in a north-easterly direction it passes over New Orleans, and traverses in succession the states of Mississippi, Alabama, Georgia, South Carolina, North Carolina, and reaches the Atlantic at Cape Henry in Virginia, Columbus in Georgia, Raleigh in North Carolina, and Norfolk in Virginia being the chief towns near the central line. Then the eclipse crosses the Atlantic, and the longest duration of totality takes place when it is a little less than half way across, some 350 miles east of Newfoundland.

The shadow track next touches land in Portugal, at a seaside resort named Ovar, some fifty miles south of Oporto. The eclipse is total for a few seconds at Oporto itself as it lies just within the shadow track. Crossing the Peninsula to the Mediterranean coast, we find a few miles south of the port of Alicante, a quaint semi-Moorish little town named Elche, and a straight line joining Elche with Ovar very nearly represents the path of the central shadow.

The track then crosses the sea again, this time across the Mediterranean, and the central line meets the African coast almost precisely at Cape Matifou, the eastern horn of the bay on the western side of which stands the city of Algiers. The line then passes eastward, nearly bisecting the province of Tunis, and entering the Gulf of Cabes, skirts the coast of Tripoli, and ends at sundown as it reaches the eastern shore of the Gulf of Sidra.

It will be seen from the foregoing that there are two great regions where the eclipse may be observed, the one on the west of the Atlantic, where the eclipse takes place before local noon, the other on the east of the Atlantic, where it takes place after local noon.

It is, of course, always a matter of great importance that the sun should not be near the horizon at the time of totality; the chance of cloud being so much greater in the case of a low sun, and atmospheric absorption necessarily interfering to a greater extent. We may, therefore, leave out of consideration that part of the shadow line which lies in Mexico, and commence with it as it enters the United States, near New Orleans. Here the sun will be 30° high at the time of mid-eclipse, which will take place at about 7.30 A.M., local time, and totality will last for 78 seconds. At Cape Henry, on Chesapeake Bay, the sun's altitude will be 47°, the local time 8.49 A.M., and the duration of totality 106 seconds. On the line joining these two stations, the altitudes, local times and durations of totality may be inferred pretty closely from their distances from the two extreme stations. Thus, at Union Point in Georgia, nearly midway between them, we find the sun's altitude 39°, the local time 8h. 8m. A.M. and the duration 92 seconds.

Cape Henry, Virginia, gives us the longest duration for any land station for this eclipse, but when we raise the question of weather probabilities we find that neither the Atlantic nor the Gulf Coasts of the United States are very promising. The weather Bureau of the United States Department of Agriculture has carefully collected the cloud statistics of a large number of stations, with the result of showing that the interior of South Carolina, Georgia, and Alabama, where the shadow track crosses the southern end of the Appalachian Mountains, offers much the best prospects, and the chances of a clear sky seem to diminish in proportion as the coast is approached in either direction. In all the three states named the weather conditions seem as favourable as can possibly be expected.

Crossing to Europe, we find the sun 42° high at Ovar, the local time 3.28 P.M., and the duration of totality 94 seconds. At Cape de Santa Pola, on the east coast of Spain, near Elche, the altitude has diminished to 34°, the duration to 79 seconds, and the local time of mid-totality is 4.11 P.M. As in the United States, corresponding particulars may be inferred for any intermediate place from its distances from these two extreme stations.

So far as the weather conditions are concerned, the prospects in Portugal are much the least favourable, the stations on the western slope of the Serra D'Estrella generally suffering from the drawback that the afternoons are cloudy at that time of the year. Broadly speaking, so far as at present known, the weather in Spain would seem to be likely to be all that can be desired, whether on the central table-land or down near the coast near the department of Alicante.

When we cross to Algeria we find the sun's altitude very nearly the same as at New Orleans; 29° instead of 30°, and the duration is only 71 seconds. The mid-eclipse takes place here at 4.31 P.M., local time. It is not likely that any observers from England will go further east.

The weather probabilities not greatly favouring Portugal, and especially the coast probably but few parties will try that country. It ought certainly not to be entirely neglected, for the experience of former eclipses has shown again and again how completely the most careful cloud forecasts will sometimes be falsified by the event. Two railways run north from Lisbon the one along the coast through Coimbra will give access to Ovar on the coast, or to Viseu inland; the other, striking inland towards Salamanca, will lead to Sabugal. These three places seem to be the most accessible on the central line in Portugal.

In Spain the principal places on or near the central line and accessible by rail are Plasencia, Navalmoral, and Oropesa. All three can be reached by rail from Lisbon or Madrid. Talavera de la Reina is the principal town upon this line, but the duration here is not quite 50 seconds, Talavera, though within the shadow, being a good deal north of the central line. Further east, Toledo just escapes the total phase, being a few miles north of the northern limit of the shadow, and from this point onwards till we reach the coast no towns of great importance are intersected by the line of central eclipse, though two railway lines,—on the more easterly of which is Alcazar, a considerable railway junction, 15 miles north of the central line,—run south from Madrid and meet at Ciudad Real after crossing the shadow track. But by far the most accessible places, especially for those with any considerable equipment, are Alicante and Algiers. Neither are quite on the central line, but the duration at Alicante will be 72 seconds and that at Algiers 66, and, so far as it is possible to predict, the probability of a very pure sky is great for the neighbourhood of both cities.

So far as at present arranged the distribution of the English official parties will be somewhat as follows:—

The Astronomer-Royal and Mr. Dyson, from the Royal Observatory, Greenwich, will probably occupy a station in Portugal near Ovar. Sir Norman Lockyer, who will be accompanied by Mr. A. Fowler and perhaps other assistants from the South Kensington Observatory, will take his place near Alicante; whilst Algeria has been chosen by Mr. Evershed, and Prof. Turner and Dr. Common will probably choose the same district.

The British Astronomical Association are engaging the splendid steamer "Tagus," of the Royal Mail Steamship Co.'s line, to take observers to Alicante and Algiers direct from England, and have arranged to call at Cadiz for the convenience of those who wish to observe the eclipse at Alcazar, and to combine with it a tour in Southern Spain. A second expedition, under the leadership of the Rev. J. M. Bacon, F.R.A.S., will proceed to the United States, probably taking their station at Newberry, South Carolina.

The most important items in the programme of observations as yet determined upon appear to be Sir Norman Lockyer's scheme for obtaining the "Flash" spectrum with a very much larger solar image than ever attempted before; Mr. Evershed's, to prolong the "Flash" by choosing a station near the edge of the shadow; and Dr. Common's, to imitate Mrs. Maunder's photographs of the coronal streamers with much more powerful instruments.

It may be assumed that the numerous methods of observation, photographic or visual, carried out or attempted in past eclipses, will be again tried next May. Photographs of the corona will be taken on all scales, from that giving the sun a diameter of 4 inches, such as the Astronomer-Royal obtained in India with the Thompson heliograph of the Royal Observatory, Greenwich, to that which gives the sun a breadth of but a very small fraction of an inch.

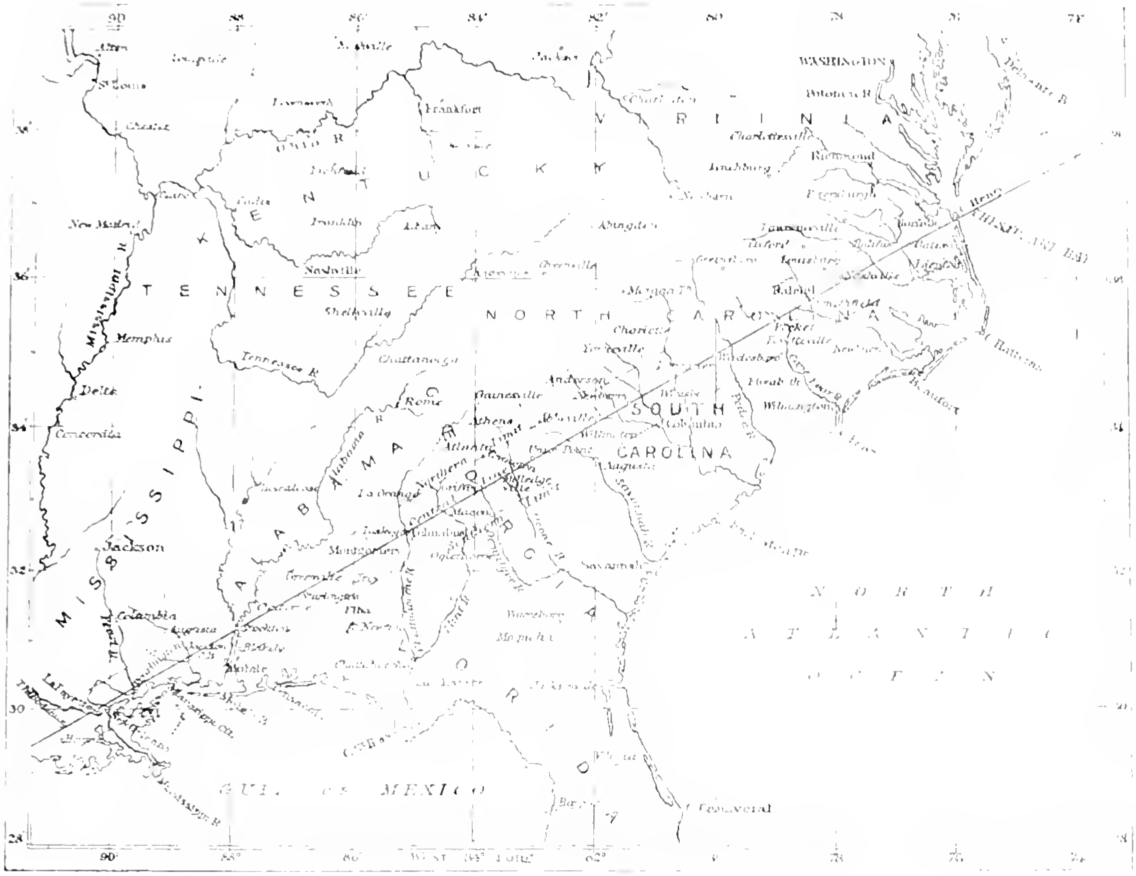
It may be again emphasized here that those photographers whose object-glasses have an effective ratio of aperture to focus not exceeding 1 to 15 or 16, will be well advised to discard any form of equatorial mount or driving clock, with its liability to shake, and insidious temptation to over expose, and rigidly fixing the camera, to give exposures not exceeding one second as a maximum.

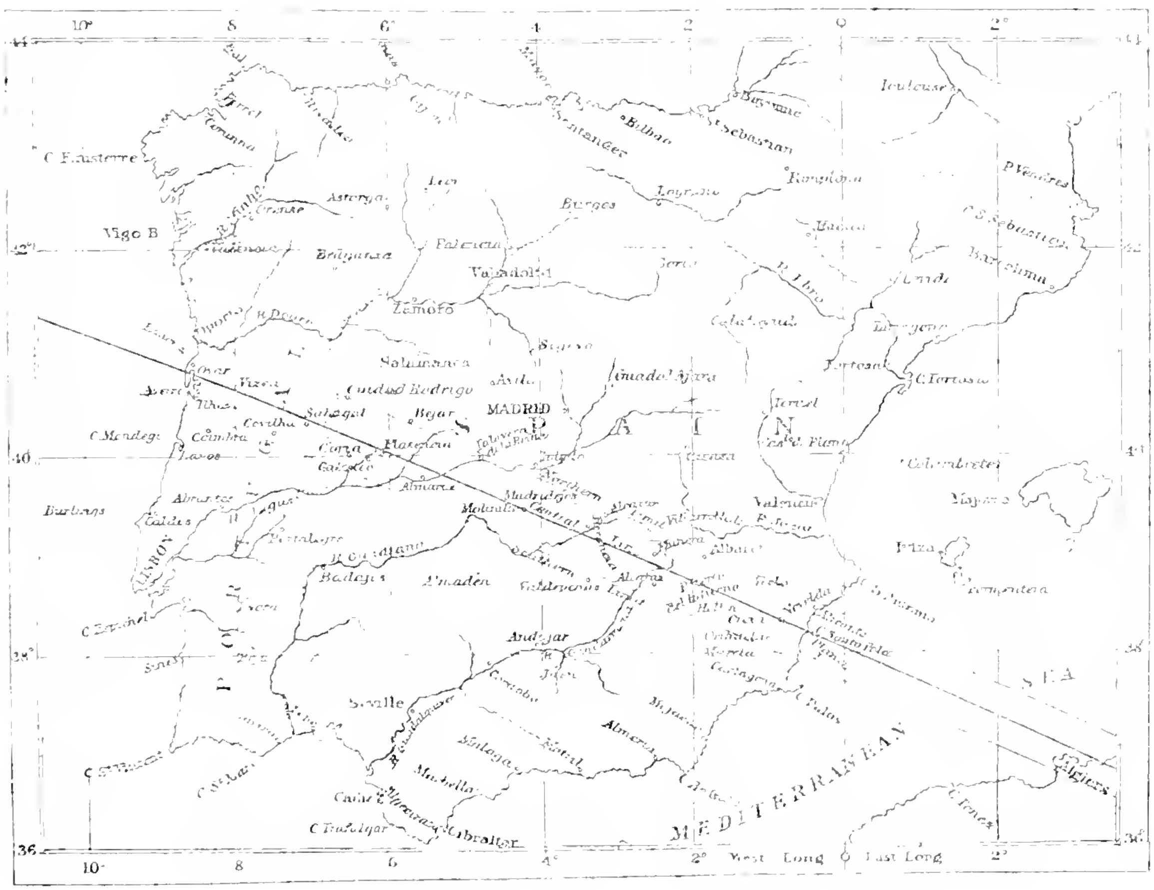
Both before and after totality a series of photographs should be taken of the Partial Phase. Since but one photograph has as yet been obtained of the Corona after totality was well over, no definite rule can be laid down as to the style of instrument that should be employed. Therefore in this next eclipse all sorts of cameras might be pressed into the service, and some range of exposure should be given. One thing is certain; that in all cases the development must be carried out with the special object of restraining the high lights and giving opportunity for the feeble radiations to register.

Mr. Nevil Maskelyne will kinematograph the corona at his station in America. A most interesting and instructive use for the kinematograph in the coming eclipse would be its adaptation to the experiments which Miss Gertrude Bacon carried out in India on the illumination of the landscape during the Partial Phase. In a series of five photographs, taken at equal intervals, Miss Bacon found the curious fact confirmed (hitherto believed to be an optical illusion) that the illumination returned more rapidly after eclipse than it diminished before eclipse. The kinematograph, if used for this purpose, would give a more even and continuous series, and if it were possible to use more than one in the same locality, would decide whether the same effect held good when the instrument was pointed in the direction from which the shadow was approaching and towards which it was receding.

Akin to this observation is that of the general illumination of the corona, which may be determined by very simple photographic sensitometers. In India this was determined photographically by Mr. E. W. Johnson (using a sensitometer constructed by Mr. Gare) and by the Rev. J. M. Bacon, and visually by

THE SOLAR ECLIPSE OF MAY 27th 28th, 1900.





Maps showing the Path of the Moon's Shadow during the Eclipse.

(Reproduced by p... ... "Nautical Almanac" Circular, No. 17.)

Mr. T. W. Backhouse and Dr. Irwin Sharp, at Buxar, and by myself at Talni, by comparing it with the evening twilight illumination.

Spectroscopic observations of all sorts will be made, from those with giant slit spectroscopes or object-glass prisms to those with the humble but portable prismatic opera-glass. Observers with the latter will probably confine themselves to the shape of the Corona as seen in the green coronium ring, the red and blue hydrogen and the yellow helium rings. To attain the same object without a spectroscopic apparatus, Mr. Shackleton suggests that it would be well to photograph the corona by light as nearly monochromatic as possible, obtaining this partly by using a film of special colour sensibility and partly by the use of a colour screen.

There are two classes of work that have been very generally omitted from systematic observation in recent eclipses. These are the observations of the shadow bands, of which very little is as yet known, and the visual study of a small portion of the inner corona. The latter is especially important for the true understanding of the curious formations that in photographs appear to enwrap the brighter prominences and which lie at the base of the great rays and the polar plumes. Only a very small portion should be attempted by any one observer since the time of totality is very short, but the study of that portion should be thorough.

Not very many English observers will seek the American portion of the shadow track, and for these there is only one method of reaching their station, i.e., by a voyage across the Atlantic. For the eastern observers there are many ways of travelling. By sea, English astronomers can join the British Astronomical Association's expedition, or go by regular lines to Bordeaux, Santander, Lisbon, Cadiz, Gibraltar, Malaga, or Algiers, from which ports they may travel inland by rail to the central line, or in the case of Algiers observe the eclipse at the port itself. For those who shirk the Bay of Biscay, it is possible to travel overland through Paris direct to Madrid from whence several railway lines cross the path of shadow, or, by taking ship at Marseilles, to cross the Mediterranean to Algiers. For the overland travellers, the chief difficulties will be in the transport of their instruments, and in the number of frontiers (which spell custom-houses and, perchance, disaster to photographic plates) which must be crossed.

ELECTRIC AUTO-PORTRAITS.

By ALEX. THURBURN.

SINCE Mr. Brown, of Belfast, described the figures he obtained by electric action on photographic dry plates in "The London, Edinburgh, and Dublin Philosophical Magazine" for December, 1888, accounts of similar experiments with plates have from time to time appeared, of which by far the most striking are those contained in Lord Armstrong's fascinating and magnificently illustrated book, "Electric Movement in Air and Water." I am, however, not aware of any such experiments having been tried with sensitized papers, although they yield interesting results, and suggest various problems, when the figures thus produced are compared with the corresponding ones on plates. If two photographic plates are placed back to back between the terminals of a discharger connected to a sufficiently powerful induction coil, and a single discharge is made to strike on them, and the plates are then developed, the image produced on the plate which faced the positive terminal resembles in size, but is different in form, from that produced on the plate which faced

FIG. 1.—Normal positive on glass.

the negative terminal. The latter can be easily recognised by the frond-like markings which form so large a part of it, as may be seen in the illustrations 1 and 2. But if, instead of glass plates, we substitute sensitized papers with a piece of glass between them to prevent their being pierced by the spark, the negative figure will be much smaller than the positive, and will

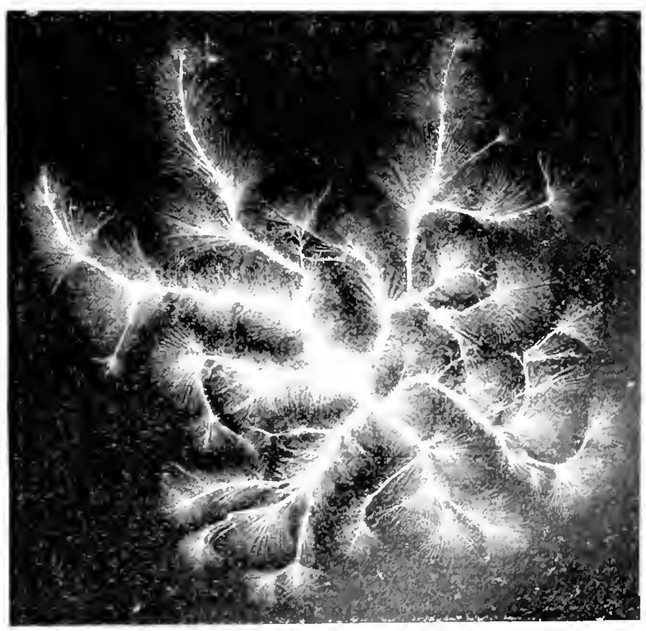


FIG. 2.—Normal negative on glass.

contain no trace of fronds. Such a negative is shown by Fig. 3. The corresponding positive figure was nearly three times larger in diameter, and the difference in size is sometimes far greater than this. It is unnecessary to reproduce the positive figure, as it does not differ in such a marked degree from the positive figures obtained on plates. The substitution of films for plates does not make much difference in the images got in respect

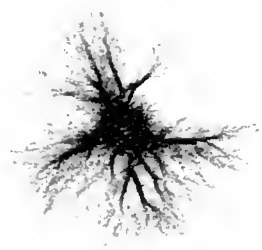


FIG. 3.—Normal negative on paper.

either of their forms or the correspondence in size of the positives and negatives.

The smaller size of Fig. 3, as compared with the companion positive figure, appears to be owing, in part, at all events, to the greater penetrative power of the discharge proceeding from the negative terminal, which carries a portion of the electricity through the gelatine, and into and beyond the paper support, so that only a part of it produces visible effects by acting on the silver in the sensitive emulsion. This may be proved by placing two sensitized papers (B and C) on each side of a piece of glass, a film of gelatine over each, and above the gelatine films two other sensitized papers (A and D), and inserting the arrangement between the terminals of the discharger, A and B being on the side next the positive terminal. If a single discharge be

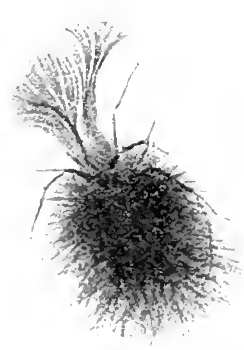


FIG. 4.—Negative on Nikko paper with Leyden jar in circuit.

caused to pass between the terminals, the negative electricity will pass through D, and its underlying gelatine to C to a greater extent than the positive does through A and its film to B, and will thus produce a larger figure on C than that on B, while the negative figure on D will, for the same reason, be smaller than the positive one on A. In several cases I found the paper B a complete blank, while C showed a well-marked image.

It would also appear that the form of the image represented by Fig. 2, as well as the smaller size of the negative images on paper, is dependent on this more effective action of the negative side of the discharge. In the first place, the negative fronds do not appear, even on plates, unless the action of the discharge is strengthened by induction, as has been shown by the experiments both of Mr. Brown and Lord Armstrong; and even if the inductive action be preserved, but the strength of the current be reduced, the resulting figures will not only be smaller in size, but be wanting in the characteristic branching character of the positive and the fronds of the negative.

On the other hand, the normal form of the negative figure on plates may be more or less closely reproduced on sufficiently rapid sensitized papers if the discharge on them be condensed by connecting a Leyden jar with the terminals of the coil, so as to act as a shunt. The figures thus obtained show, in addition to the fronds, the ordinary rayed paper form of the negative discharge (see Fig. 4), which appears to be produced by a portion of the current which passes directly to the paper without

FIG 5.—Exterior paper negative with Leyden jar.

proceeding along the shunt wires that lead to the jar. If two pieces of paper be used, one above the other, as in the quadruple sets just described, this direct current will be too feeble to penetrate the outer paper D, while the other portion of the current, condensed by the Leyden jar, will pass through D, and act solely on C. D will thus show only the ordinary paper figure (Fig. 5), and C will show one composed entirely of fronds (Fig. 6).

The fronds can, however, be produced on paper with greater ease and certainty by other methods. If oil be spread on the back of sufficiently rapid paper, so as to make it translucent, before it is exposed to the discharge, the negative image will then be covered with fronds as handsome as those produced on glass, and it will also be of equal size with the positive image, which, for its part, will contain the branchings characteristic of positives on glass plates. The same results may be obtained in a smaller degree by turning the sensitized side of the paper which is near the negative terminal towards the glass, or by keeping the sensitized side outwards, and covering it with a thin sheet of glass, gelatine, or the like. In the last mentioned case the images are somewhat blurred, and the fronds sometimes very small, though the figures, as a whole, are large, as in other cases where fronds are produced.

As the ablest electricians are not yet agreed as to what is the real nature of electricity, I shall not presume to enter on a discussion involving this question, but if any readers interested in such speculations will refer to Lord Armstrong's "Electric Movement in Air and Water," they will probably be struck with how readily the theory broached by him lends itself to an explanation of the experiments above described. The concentrative character of the negative current, as opposed to the dispersive character of the positive, which is involved in his theory, fits in well both with the more penetrative power of the former, and also with its being less easily diverted by resistances when moving in the plane of the paper, and thus forming smoother curves when the homogeneous nature of the support for the sensitive film admits of this.

The method of receiving the spark discharge on a photographic plate may also be employed to show the oscillatory character of the discharge of a Leyden jar. As is well known, this discharge is not one simple operation, but if we suppose the inside to be charged positively, then, when the jar is discharged, this positive charge does not merely leave the inside, but surges over to the outside and charges it positively, instead of negatively, as it was before. This new positive charge on the outside then surges back to the inside, and this

Fig. 6.—Negative lying below Fig. 5.

oscillatory process is repeated with inconceivable rapidity until the oscillations gradually die away. Fig. 7 is taken from a plate which faced the negative terminal, and yet it will be seen that the positive markings from the oscillation caused by the Leyden jars extend nearly as far as the negative ones. Even when there is no Leyden jar in the circuit, there may be oscillations in the discharge of sufficient strength to show themselves on the plates. On closely examining Fig. 2, there will be seen small positive twigs projecting from some of the main lines, while negative fronds may be traced, though less easily, on Fig 1. I have found, in general, that the superior efficiency of the negative discharge asserts itself here also, so that the effects of its return as a positive charge are more easily recognized in the negative plates than are those of the negative return swing of the positive charge on the positive plates. When the Wehnelt interrupter was used instead of the ordinary contact breaker, then, even though there was no Leyden jar introduced, the glass plates showed the central rayed figures, in addition to the normal positive branches and negative fronds. As I

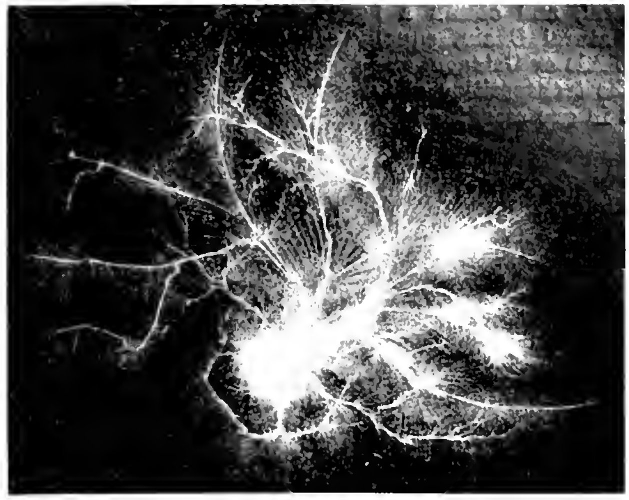


Fig. 7.—Glass negative with two Leyden jars, showing oscillations.

had cut out the condenser when using the Wehnelt interrupter, these rayed figures were probably produced by the spark at "make," and the normal ones by the spark at "break." If the spark be allowed to pass freely between the terminals of the coil, with no plate or other obstacle interposed, the portion which produces the rayed figures will be seen to be of a dull magenta colour, while the other portion has the usual white colour. Oscillations were well shown on some of the images produced with the Wehnelt interrupter. It will be seen that these experiments can easily be reproduced, and any one who repeats them under varying conditions will find that they exhibit a number of details which it would be of more interest for readers to work out for themselves than to have them minutely described for them.

POLARITY IN MAGIC SQUARES.—II.

By E. D. Little.

IV. Natural Chain.—The numbers 1 2 3 4 5 6 7 8 9 may of course be arranged in the form of a square in such a way that every two successive numbers in the series shall occupy contiguous positions in the square, as in the following examples:—

1	2	3
6	5	4
7	8	9

Fig 5

6	1	2
7	5	3
8	9	4

Fig 6.

It will at once be seen that the first of these squares only requires the transposition of 1 and 6 to become identical with the Natural Square, and that the other by the transposition of 2 and 8 becomes the Magic Square. The only difference in principle between the two squares is that 1 in the first is placed in a corner position, and in the other in a middle position, of a row.

By pushing out the middle positions of the outside rows and columns, so as to convert the squares into circles or octagons we may take the two figures identical, and obtain a figure which may be called the Natural Chain, equally convertible into the Natural Circle or Octagon, and the Magic Circle or Octagon by the transposition of two opposite even numbers, 4 and 6 in one case, 2 and 8 in the other.

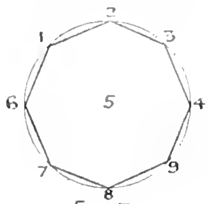


Fig. 7.

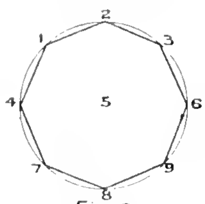


Fig. 8.

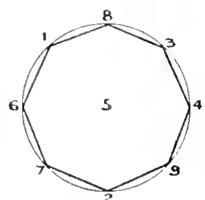


Fig. 9.

The law of polarity between the Natural Circle, or Octagon, and the Magic Circle, or Octagon, is of course precisely the same as that of polarity between the Natural and Magic Squares, but it admits of a different expression

For in the Circle, or Octagon, the external rows and columns of the squares have become arcs, or triangles, while the middle rows and columns, as well as the middle diagonals have become diameters. The polarity of the two figures may therefore be stated as follows:—

In the Natural Circle the Natural Rows and Columns have become four arcs each equal to a quadrant and two diameters: the Magic Rows and Columns have become four arcs each equal to three quadrants and two diameters. In the Magic Square the statement must be reversed.

In the Natural Octagon, the Natural Rows and Columns have become four obtuse angled triangles, each on a side of a square, and two diameters; the Magic Rows and Columns have become four acute angled triangles, each on a side of the square, and two diameters. In the Magic Octagon the statement must be reversed.

In the Natural Triads in either figure an even number forms the vertex of a triangle, in the Magic Triads an odd number forms the vertex.

This connection of a Natural Figure with its complementary Magic Figure through the intermediary Natural Chain leads to the enquiry whether there is any other Natural Figure connected thus closely, or more so, with its complementary figure, and to the discovery that 1 2 3 4 5 6 7 can be arranged as a natural chain in a figure which may be described as perfectly natural, and at the same time perfectly magic.

If a hexagon be formed of six equilateral triangles placed with their vertices at a point, the numbers 1 2 3 4 5 6 7 may be placed as in figure 10, where

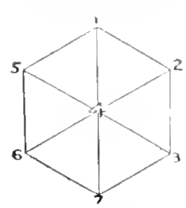


Fig 10

The numbers form a continuous chain, all the links of which are of equal length.

Each of the five natural triads, or triads of numbers in natural order, lies on three successive positions, 1—2—3, 2—3—4, 3—4—5, 4—5—6, 5—6—7.

Each of the five magic triads or triads of numbers having equal Summation (12) lies on three successive positions, 1—4—7, 1—5—6, 2—4—6, 2—3—7, 3—4—5.

It is somewhat surprising that this figure was not adopted by the Ancient Mystics and Astrologers as a perfect presentment of the sacred and planetary number seven combined with the equally sacred and fundamental number twelve.

V. Paths.—We have already had occasion to regard the Series 1 2 3 4 5 6 7 8 9 as a recurring Series, and on the same principle we may regard a number-square as capable of extension, without alteration in its character, by repeating its rows and columns in their original order. Let the Natural and Magic Squares of 3 then be extended, first by repeating two rows above and below the square, and then by repeating two columns of the resulting rectangle of numbers to the right and left.

We shall then have the squares shown in the following figures 11, 12, 13, 14, 15, 16.

5	6	4	5	6	4	5
8	9	7	8	9	7	8
2	3	1	2	3	1	2
5	6	4	5	6	4	5
8	9	7	8	9	7	8
2	3	1	2	3	1	2
5	6	4	5	6	4	5

Fig. 11.

5	3	7	5	3	7	5
9	4	2	9	4	2	9
1	8	6	1	8	6	1
5	3	7	5	3	7	5
9	4	2	9	4	2	9
1	8	6	1	8	6	1
5	3	7	5	3	7	5

Fig. 12.

5	6	4	5	6	4	5
8	9	7	8	9	7	8
2	3	1	2	3	1	2
5	6	4	5	6	4	5
8	9	7	8	9	7	8
2	3	1	2	3	1	2
5	6	4	5	6	4	5

Fig. 13.

5	3	7	5	3	7	5
9	4	2	9	4	2	9
1	8	6	1	8	6	1
5	3	7	5	3	7	5
9	4	2	9	4	2	9
1	8	6	1	8	6	1
5	3	7	5	3	7	5

Fig. 14.

5	6	4	5	6	4	5
8	9	7	8	9	7	8
2	3	1	2	3	1	2
5	6	4	5	6	4	5
8	9	7	8	9	7	8
2	3	1	2	3	1	2
5	6	4	5	6	4	5

Fig 15

5	3	7	5	3	7	5
9	4	2	9	4	2	9
1	8	6	1	8	6	1
5	3	7	5	3	7	5
9	4	2	9	4	2	9
1	8	6	1	8	6	1
5	3	7	5	3	7	5

Fig 16

In Figs. 11, 12, we see that in the extended Natural Square the Magic Square is latent, with its rows and columns in Bishop's paths, while in the extended Magic

Square the natural square is latent in exactly the same way.

In Figs. 13, 14, each Square is seen to be latent in the other with its rows and columns in Knight's paths.

In Figs. 15, 16, each square is seen to be latent in the other with its rows (or columns) in Knight's paths, and its columns (or rows) in Bishop's paths.

Polarity of direction with regard to paths is thus established.

VI. Notation. If each number of the Natural Square is denoted by a combination of two letters A, B, or C, and a, b, or c, one denoting the row, and the other the column of the Natural Square in which the number occurs, the notation of the Natural and Magic Squares, Fig. 2 and Fig. 1, will respectively be:—

Aa	Ab	Ac		Bc	Aa	Cb
Ba	Bb	Bc	and	Ca	Bb	Ac
Ca	Cb	Cc		Ab	Cc	Ba

Now let the Magic Square Fig. 1 be written in similar notation:—

Aa	Ab	Ac
Ba	Bb	Bc
Ca	Cb	Cc

the notation of the Natural Square will then be:—

Ab	Ca	Bc
Cc	Bb	Aa
Ba	Ac	Cb

which is seen to be precisely the same as the notation of the Magic Square in terms of the Natural Square, except that the rows of one are the columns of the other.

If the rows and columns of either of these squares formed from the other are examined it will be found that in any row or column of either, every row and column of the other is represented. Or to put it in another way, every capital letter and every small letter is found in every row and column of either square.

The existence of a law under various aspects, and the essential unity of the law, has now been as fully illustrated as our space permits. It is needless to say that if a square of higher dimensions is subjected to the same sort of analysis many more illustrations of the same law are discovered, but their very multiplicity is rather a disadvantage than otherwise. It is the simplicity of the 3 squares which makes it such a good "subject." Under whatever form the law may appear in greater squares we may be sure that the same principles underlie it in all cases. Whatever rules have been heretofore devised, or may be devised hereafter, for the construction of magic squares—must be based upon the same principles.

PLANTS AND THEIR FOOD.—II.

By H. H. W. Pearson, M.A.

We have seen that more than half of the substance of a plant is composed of Carbon.* Carbon, therefore, is the most important constituent of plant food, and we will now consider whence and in what form it is obtained. The forms in which this element is found in Nature are not numerous, although there is an immense quantity of it. It exists in the pure form, as is well known, in Diamond and Graphite (of which "lead" pencils are made); combined with other elements it is found in great abundance in the air as Carbon dioxide gas,† and in the earth in the form of Carbonates (e.g., Dolomite, Limestone, Chalk, &c.). It also occurs nearly all over the earth's surface as organic matter, which is the result of the alteration and decay of the dead bodies of animals and plants. Plants obtain their Carbon mainly from the Carbon dioxide in the air.

"Organic" substances were so called because it was thought that they could only be produced in the course of the processes of life in a living animal or plant. They were therefore considered to be of an essentially different character from simpler substances such as Carbon dioxide, Nitric Acid, &c., which the chemist could prepare in his laboratory. In 1828, however, a German chemist succeeded in preparing artificially a solid compound called "Urea," which, before that time, was supposed to be produced only in the body of a living animal. Since then many more of the so-called organic substances have been fabricated by chemists. We now believe that in the course of time the chemist will be able to prepare artificially all the substances which are found in animals and plants, or at least, compounds which are chemically identical with them. The term "organic" can therefore no longer be used in the sense in which it was at first applied to these substances, but as a matter of convenience it is still customary to use the term to include the very large number of compounds which Carbon makes with other chemical elements, although many of them are now quite as easily made as a simple inorganic substance. For our present purposes we may say that an organic substance is a compound of Carbon and Hydrogen (or Nitrogen), which usually contains Oxygen as well, and frequently other elements (e.g., Phosphorus and Sulphur) in addition.

Certain plants, such as the Fungi, obtain the whole of their Carbon from organic matter which they find in the soil or other substances upon which they grow. Others, however, which contain the green colouring matter, chlorophyll, in their leaves, derive at least part of their Carbon—it may be all—from the Carbon dioxide in the air. It is with these green-leaved plants that we are most generally familiar. The green colour, although present, is in some cases masked by other tints, as in the leaves of the common red cabbage and the "copper" beech. For the present we shall consider the Carbon food-supply of green plants only.

Air contains a very small proportion of Carbon dioxide. It was found during 1898 that in the air of the Royal Gardens, Kew, at a height of 4 feet 6 inches from the ground, there were from 2.7 to 3 parts of Carbon dioxide in 10,000 parts of air.‡ Thus, although the stock of Carbon in the atmosphere taken in the aggregate is immeasurably large, it is in an extremely diluted condition, and we cannot easily form any idea of the vast amount of air which must be drained of its Carbon in order to supply the needs of the world's green vegetation. It has been calculated that in attaining its full size, a single tree having a dry weight of 11,000 lbs. has abstracted all the Carbon from over 15 million cubic yards of air.§

The Carbon thus taken from the atmosphere is not,

* Knowledge, January, 1900.

† Carbon dioxide is that constituent of the air which causes lime water, exposed in an open dish, to become "milky." A few other gases which contain Carbon are also found in the atmosphere in certain localities, e.g., Marsh gas.

‡ Presidential Address to the Chemical Section of the British Association, Dover, 1899.

§ "A Text-book of Botany," by Strasburger, Noll, Schenck, and Schimper (English translation), p. 196.

however, lost to it, but sooner or later finds its way back again in the form of Carbon dioxide from the lungs of animals and from burning or decaying organic substances. From every coal fire Carbon returns into the air from whence it was taken by the vast forests which flourished untold ages ago. There is thus maintained a continuous circulation of Carbon, from its gaseous form (Carbon dioxide) to the more or less solid state in animals and plants; here it is presented in an organic form, sooner or later to be destroyed, once more setting the Carbon free to rejoin the air as Carbon dioxide.

The knowledge which we at present possess of Carbon dioxide in its relation to green plants is the result of the patient labours of many investigators extending over a long period. As an example of the methods which have been used to throw light upon this problem, it will be interesting to notice one historic experiment. In 1844 a French chemist tried to prove that Carbon dioxide is actually taken from the air by green leaves. He placed a leaf-bearing branch of a vine in a large glass vessel, which was afterwards closed so that no air could enter or leave it except through two tubes. He then passed a very slow stream of air through it by way of these tubes. It was found that the air which left the vessel during the daytime contained less Carbon dioxide than that which entered it; from this he rightly concluded that some had been removed by the leaves of the vine. It is now well known that all green leaves remove Carbon dioxide from the air during the day. Although it is impossible to see this actually taking place, it is not difficult to observe two other phenomena which almost always go on at the same time. As Carbon dioxide enters the leaf Oxygen gas leaves it and solid starch is formed within its cells. By means of a little simple manipulation it is quite easy to observe the appearance of the one and the escape of the other.

Let us first consider the escape of Oxygen. A small green water-plant* should be placed in a glass flask or test-tube, which is quite filled• with water. The glass vessel is then turned upside down and made to stand upon its open end in a tray of water. Sunlight is now allowed to fall upon the plant, and almost immediately minute bubbles are seen to form upon various parts of it: these rise and collect at the top of the vessel. By using the proper chemical tests this gas can be shown to be almost pure Oxygen. The same thing happens in green leaves growing in the air; but in this case the chemical action evades observation.

To show the presence of starch in a green leaf requires a little more time. It is well known that if a drop of a solution of Iodine be placed upon a few granules of starch, a blue stain is produced. Upon this fact is founded the method by which we find out whether a leaf contains starch or not. A thin leaf (such as the common Nasturtium or Indian cress, Tropæolum majus) is boiled for about one minute in water, and then placed in spirits of wine until all the chlorophyll is dissolved out, and the leaf becomes colourless. It should then be placed in a weak solution of Iodine.•• If the leaf contains starch it will be stained blue or black; if, however, no starch was present, the Iodine would only colour it light yellow or brown.

Inside the cells of the leaf the Carbon dioxide is decomposed—that is, separated into its elements, Carbon and Oxygen. Oxygen escapes and the Carbon enters into combination with Hydrogen and Oxygen (which have come from the roots in the form of water and mineral salts), and an organic substance is formed. This series of changes—in the course of which the Carbon of Carbon dioxide becomes Carbon of an organic compound—is spoken of as the "Assimilation of Carbon dioxide," or, more briefly, "Assimilation." Of the intermediate steps of this series of changes very little is known. We do not know, for instance, what is the first organic substance to be formed, but it is nearly always the case that starch appears in the leaf very soon after it commences to assimilate. This fact provides a means of studying the conditions under which a green leaf will assimilate, for, as we have seen, it is quite easy to find out whether starch is present. If, for example, we put a growing plant into a dark cellar for several hours and then test its leaves with Iodine, we find no starch. Here is a proof that leaves do not assimilate in the dark, from which it follows that, in Nature, assimilation goes on only during the daytime. A leaf contains more starch at sunset than at any other time of the day, as would be expected; in the night the starch which was formed during the day is removed, and in the early morning a leaf contains very little or none at all.

That the formation of starch takes place in the light and not in darkness can be shown in a very striking manner by means of a photographic negative.†† A leaf is emptied of its starch by keeping the plant on which it grows in the dark for several hours. It is then laid flat on some support and covered by a negative and exposed to sunlight for some hours. On testing it for starch with Iodine, a print of the negative will be obtained; those parts which were beneath the dark portions of the negative being uncoloured, for they contain no starch; the light parts of the negative will be represented by starch stained black by Iodine.

Assimilation only goes on in the green parts of a plant. The leaves of many ornamental plants are variegated—that is, they are not green all over, but "dashed" with white or some other colour. If such a leaf—e.g., variegated Ivy—is pulled at the end of a summer's day and tested for starch, the white parts will not be coloured blue by Iodine, but all the starch will be found in the green parts. It is therefore only the green parts of the leaf which are able to assimilate Carbon dioxide; in other words, the power of assimilation resides in the chlorophyll, which possess this power only when the leaf containing it is in the light.

We have now to consider how air and the Carbon dioxide which it contains find their way into the leaf. Simple as this problem appears on paper, it is only since 1895 that it has been at all clearly understood. The cells which form the upper surface of a leaf are in most cases brick-shaped, and fit together like tiles in a pavement, leaving no openings between them. On the lower side, however, numerous very minute pores between the cells lead into the interior of the leaf. These openings are called "Stomata" (from the Greek word, Stoma, a mouth); each stoma is surrounded by two special guard-cells, which under some circumstances alter their shape so much as to close or nearly

* The so-called "Canadian" water-weed (*Elodea canadensis*) is suited for the purpose. All natural waters contain dissolved Carbon dioxide, from which submerged green plants obtain their supplies.

• "Quite filled" so that when turned upside down no bubble of air should be present in the water.

•• "Tincture of Iodine" diluted with water until it has the colour of dark beer.

†† W. Gardiner, in *Nature*, Vol. XLI. (1890), p. 16.

close the opening between them. Sometimes stomata are found on the upper side of the leaf; in most cases, however, they are more abundant on the lower, and, as a rule, are quite absent from the upper.

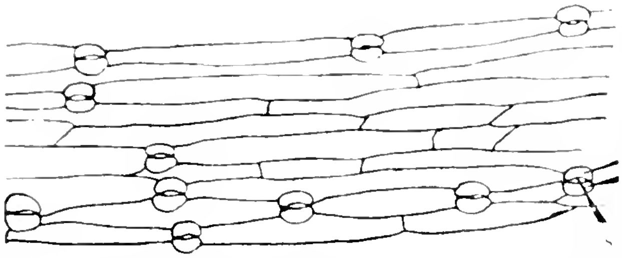


FIG. 1.—A Surface View of a portion of an Iris Leaf showing the Stomata. S, a Stomata; G, the Guard-cells surrounding it. × 100.

They are found in great numbers, as the following figures show. The Pæony leaf has none on its upper side, while on the lower there have been counted 13,790 per square inch; in the leaf of the Cherry laurel (Prunus Laurocerasus) there are none on the upper side, but 90,000 per square inch on the lower. It seems natural to suppose that the gases of the atmosphere enter the leaf by way of the stomata, and such is indeed the case, although it is only within the last five years that this fact has become known. Previously it was always stated that Carbon dioxide entered through the walls of the close-fitting cells of the upper side. A complete proof of the fact that it enters by the stomata requires a very complicated piece of apparatus.‡‡ A simple demonstration is, however, easily made. A plant whose leaves have all their stomata on the lower side—e.g., the Nasturtium mentioned above, or Syringa (Philadelphus coronarius)—is placed in the dark until all its starch has disappeared. A thick layer of vaseline is then smeared over half of the lower surface of one or more leaves. In this way the stomata of the smeared half of the leaf are closed so that no air can enter them. The plant is now placed in the light and allowed to remain there for some hours. The "vaselined" leaves are afterwards removed and tested with Iodine in the usual manner. Starch is found only in those portions of the leaves whose stomata were not closed by vaseline. No assimilation then takes place where the stomata are blocked against the entrance of Carbon dioxide, which shows that they are literally the "mouths" by way of which the plant receives its Carbon.

The stomata open into passages which wind about among the cells of the leaf. The air which enters passes round and between these cells, giving up to them Carbon dioxide and receiving from them Oxygen and the vapour of the water which passes out through the stomata. Inside the cells are protoplasm and cell sap, as in the living cell already described.§§ In the semi-liquid protoplasm are embedded numerous green oval bodies called "chloroplasts." These are distinct masses of protoplasm which contain the chlorophyll, and to them is due the green colour of the leaf. It is within the chloroplasts that the process of assimilation goes on; if they are observed under the microscope while the leaf is assimilating, minute granules of starch may be seen to appear in them. Thus we are able to identify the exact spots where this wonderful process of the conversion of inorganic Carbon into organic is carried on. It is upon the work performed in these minute chloroplasts that the whole organic world—plants and animals—depends for its supply of Carbon; for animals as well as those plants and parts of plants which contain no chlorophyll can only obtain their Carbon from organic substances.

FIG. 2.—A portion of a Transverse Section through a Leaf of the Cherry Laurel. S, a Stoma. I C, spaces between the cells into which stomata open. × 100.

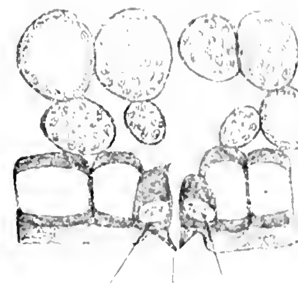


FIG. 3.—A small part of Fig. 2, enlarged. S, a Stoma. G, Guard-Cells. × 400.

What is the secret of this remarkable power which chlorophyll possesses? To this question no satisfactory answer can at present be given. Before the processes which are carried on in the chloroplasts can be understood we must learn much more about protoplasm than is yet known. We have seen that chlorophyll cannot decompose Carbon dioxide and build up organic substances in the dark. If we try to decompose Carbon dioxide by artificial means we find that it is difficult, and can only be effected by a very high temperature. The heat which we apply is transformed into another form of energy, which forces apart the atoms of Carbon and Oxygen and so brings about the decomposition. The separation of these elements when they are combined in the form of Carbon dioxide is only possible when there is a supply of energy from outside. When it takes place in the chloroplasts of the leaf, this energy is undoubtedly derived from light. Ordinary sunlight, however, is incapable of effecting the change by itself. In passing through a solution of chlorophyll, white light undergoes alteration, some of its constituents being absorbed by the chlorophyll and others passing through. The secret of the decomposition of Carbon dioxide in the chloroplasts lies in this fact, viz., that some of the constituent colours of sunlight are arrested and others transmitted by the chlorophyll. In the present state of knowledge it is impossible to go farther than this without becoming involved in speculations which are insufficiently supported by practical experiment. We must for the present rest content with the statement that the assimilation of Carbon dioxide goes on only in protoplasm which contains chlorophyll, and under the influence of light.

All green plants, under favourable conditions, assimilate Carbon dioxide, and undoubtedly obtain the greater part of their Carbon in this way; it is, however, by no means certain that some of it does not come from organic substances in the soil. We shall have another occasion

‡‡ F. F. Blackman, *Philosophical Transactions of the Royal Society*, 1895.

§§ KNOWLEDGE, January, 1900.

to refer to this question, which has been much debated, and is still undecided. We know, however of some green plants which certainly use organic substances as the source of part of their Carbon. Some have contrivances by which they capture insects, from whose bodies they afterwards draw organic nourishment; among these are the Bladderwort (Utricularia vulgaris) and the Sundew (Drosera rotundifolia), both of which are British plants. Others are more or less dependent upon living plants for part of their organic food supplies; these are called "parasites," and include such well-known plants as "Eyebright" (Euphrasia officinalis), and the "Yellow rattle" (Rhinanthus Crista-galli), whose roots attach themselves to the roots of other plants. Many ground orchids are known to live partly upon organic substances which are found in the humus of the soil; plants such as these, which derive more or less of their nutriment from dead organic substances, are known as "Saprophytes."

Notices of Books.

"Animal Biology." An Elementary Text-Book. By C. Lloyd Morgan, F.R.S. Third edition. Revised. (Longmans. 8s. 6d. Professor Lloyd Morgan's little book was first published twelve years ago, and was written to meet the requirements of students preparing for the Intermediate Science and Preliminary Scientific Examinations of the London University. But since the appearance of the book the syllabuses for these examinations have been altered, and the opportunity of the demand for another edition has been taken to modify the contents of the volume so that it may still serve its original purpose. But though the anatomy of the bird has disappeared from the syllabus, we are glad the chapter on this subject has been retained, for its inclusion may tempt the undergraduate to read it and so obtain a broader view of the animal kingdom than a rigid adherence to examination requirements would secure. Professor Morgan's book retains nearly all the excellent qualities for which it has become widely known, and the number of illustrations has been increased. The early chapters of the first edition, dealing in succession with general anatomy, physiology, histology, and embryology, have given place to a more formal treatment of the frog, dogfish, amphioxus, rabbit and pigeon, in separate chapters. Similarly, in the new edition, a single chapter on physiology takes the place of separate chapters on nutrition and metabolism, the heart and circulation, and the brain and nerves. It is very questionable whether the new arrangement is an improvement. In the opinion of the writer, one of the charms of the older order was that a constant comparison was inevitable, and the continual insistence upon likenesses and differences was a source of stimulation which we fear may be absent from the new edition. But at the same time we have no hesitation in heartily recommending the book as a clear, exact, up-to-date introduction to animal biology. Undoubtedly the volume will retain its position as one of the best means of arriving at a knowledge of the subjects of which it treats.

"Optics. A Manual for Students." By A. S. Percival, M.A., M.B. (10s. net.) "Handbook of Optics for Students of Ophthalmology." By W. N. Suter, B.A., M.D. (London: Macmillan & Co., Limited. New York: The Macmillan Company. 1899.) It is recorded in the Annals of Cambridge University that once in answer to "State and prove Taylor's Theorem" a questionist replied that he did not just then recollect how it was done, but that it would be found on page 72 of Todhunter's "Differential Calculus." It is all very well for a student to limit his idea of the use of a text book by its usefulness for examination purposes, and by so studying it from cover to cover to form an index in his head of its contents, but it is by no means well for the author to neglect or ignore the far larger body of students whose academic examinations are receding rapidly into the past, and whose present life is so full of practical questions that they have no time to read through a whole book or chapter of irrelevant matter to find the answer that they seek. So in the first of these two books on the science of optics for ophthalmic students the great fault we have to find with Mr. Percival's excellent treatise is the omission of any sort of index to the text. Dr. Suter has not made this omission. His book is smaller, more elementary, but perhaps more practical. The difference may be thus expressed:—Mr. Percival has written a text-book for students, Dr. Suter a manual for oculists. Mr. Percival's book is delightful reading; he explains most lucidly the wave-theory of light, and from its principles deduces the laws of reflexion, refraction, diffraction, dispersion, and caustics. The reader clearly understands the reasons for ametropia, aphakia or astigmatism, but in the case of the last would find it difficult to look for anything about it, unless he had already read through the entire book. Perhaps the ordinary oculist would understand better how to draw out a prescription for glasses from Dr. Suter's explanations. On the other hand, Dr. Suter leaves out all about first principles, and takes for granted as much as is possible of the theory. Taken together, these two manuals would form a very excellent addition to an oculist's or even an astronomer's library.

"An Easy Guide to the Constellations with a Star Atlas." By the Rev. James Gall. (London: Gall & Inglis, 25, Paternoster Square. 1900.) We are glad to see a new and enlarged edition of this little book, and would desire a wide circulation for its admirably clear maps and descriptions of the constellations and their principal stars. Seeing, however, that it is a new edition, we regret to see retained in it one or two theories which have no basis in fact, or are absolutely wrong. For instance, the theory is quoted that connects the naming of Libra with the equal balancing of day and night at the equinoxes (p. 13), and on p. 38 we have again dragged in the modern myth of a central sun in the Pleiades. There seems to be some discord between the map 29 of the constellations and the constellation figures; one of them has been turned through 90° with respect to the other. And why should poor Cassiopeia, a queen and enthroned, be made to bear the loss of her garments as well as of her daughter?

"Science and Faith; or Man as an Animal, and Man as a Member of Society, with a discussion of Animal Societies." By Dr. Paul Topinard. Translated from the Author's MS. by T. J. McCormack. (Kegan Paul.) It is somewhat difficult to realise for what class of readers the first portion of this volume is intended, since in the account of the relationship of man to the lower animals (which to the trained naturalist is superfluous) the terms employed are so technical as to be quite beyond the comprehension of the "man in the street." Moreover, the naturalist himself will take exception to some of the terms used—notably the proposal (p. 6) to designate the Old World monkeys as Pithecidæ, no such genus as Pithecus existing. Again, a misprint like Archeul (p. 14) instead of Acheul; and, still more, the expression "nineteen vertebræ" (p. 16) instead of "nineteen dorso-lumbar vertebræ," will tend to somewhat shake confidence in the accuracy and capacity of the translator. But let this pass. The work, as a whole, may be regarded as the extreme development of anthropology from the point of view of a French free-thinker; carrying it, indeed, out of the domain of physical into that of psychical science. As we glean from the preface, the author's object is to demonstrate that anthropology, supposing it not to concern itself with societies, discovers in man an animal only; man in his primitive stage is perforce subjective, and by a rigorous natural logic egocentric; the law of self-preservation, as determining his conduct, both towards nature and his fellow-animals, is paramount with him. Sociologically considered, therefore, man's animality, his inherited egocentrism, is the source of all social difficulties. And this real or apparent contradiction between the individual and society, between social evolution as it is and as it should be, constitutes the problem for solution. It has to be demonstrated firstly, how man has evolved from an egocentric to a sociocentric animal, and, finally, what guide does the past furnish for the future. The answer, in a word, is that a rationally and sociocentrically acquired ego, mechanical in its habits and super-individual in its impulses, is to be substituted for the primordial, self-seeking animal ego. Although we are not concerned to enquire whether the learned author is right or wrong in his conclusions, we may venture to suggest that some at least of his doctrines are not of a very comforting or hopeful nature. As an example, we quote the following passage from page 261: "How on our planet was the first granule of protoplasm formed? The end, so far as we are concerned, we know. Our earth will cease to be habitable. It will grow cold, will doubtless lose its atmosphere, its humidity, and will resemble our present moon. Evolution, from having been progressive, will become stationary, then retrogressive. Some day, as Huxley has asserted, the lichens, the diatoms, and protococcus will be the only living beings adapted to the conditions, and finally there will be nothing. As for our sun, when it shall have exhausted its present store of fuel, when it shall have become habitable, and shall have had its ascending and descending evolutions, and lost also its human phase, it, too, in its turn will become a dead star lost in space, and other systems will begin and will shine for a period, to end as the others have ended. And to what purpose is it all?" With the remark that the author considers it to be our wisest course to humbly confess our inadequacy and take refuge in agnosticism, we venture to delegate the further consideration of what is certainly a very remarkable work to the personal judgment of our readers.

"Egyptian Magic." By E. A. Wallis Budge, M.A. (Kegan Paul.) Illustrated. 3s. 6d. Magical names, spells, enchantments, formulæ, pictures, figures, amulets, and the performance of ceremonies accompanied by the utterance of words to produce so-called supernatural results, have held men and women in awe, more or less, throughout all ages. Still, it will be a revelation to many who peruse the pages of this book to find how lofty was the spiritual character of the Egyptians who flourished at the dawn of history—a strange religion mixed incongruously with magical ceremonies, which savoured of gross and childish superstition. In those early days "unscrupulous but clever men took advantage of the ignorance of the general public, and pretended to knowledge of the supernatural, and laid claim to the possession of power over gods, and spirits, and demons. Such false knowledge and power they sold for money . . . to further any sordid transaction, or wicked scheme, which the dupe wished to carry out." The volume is the second of a series on Egypt and Chaldea, and, we think, a most desirable series on matters relating to the archæology, history, language, and religion of the Egyptians, Assyrians, and Babylonians.

"The Rise and Development of the Liquefaction of Gases." By Dr. Willett L. Hardin. (Macmillan.) Illustrated. 6s. As the literature on this subject is in the main scattered in generally inaccessible publications of learned societies, and as the roof of the whole fabric has been put on by the researches of Pictet, Cailletet, Dewar, and others, it is fitting that the complete story should be gathered within the limits of a handy volume. The ground covered is more or less common to most of the sciences—chemistry, physics, mechanics, and so on; therefore, a distinct individuality, as it were, in the form of a separate treatise is a desideratum. Considering the immense difficulties to be encountered in such an undertaking—a legion of sources to consult, great discretion in the selection of facts, and acute insight necessary for the abridgment of detached articles—Dr. Hardin has done his work well. The result is a book which will satisfactorily meet the requirements of the popular reader, and certainly prove a most valuable accession to the necessarily limited library of all science students who aspire to academic honours. Its utility is immensely augmented by the free use of references to original memoirs, all along the line, from Faraday's liquefaction of chlorine in the year 1823, to Professor Dewar's most recent papers on hydrogen, as well as to the earlier researches of Van Helmont and others on gases, as far back as the sixteenth century.

"The Advance of Knowledge." By Lieut.-Col. W. Sedgwick. (George Allen.) 6s. A thoughtful work in which the author valiantly grapples with problems of overwhelming magnitude. A quotation from Buckle indicates the trend of the writer's attitude as regards the advance of knowledge. He says—"'Our facts have outstripped our knowledge, and are now encumbering its march. The publications of our scientific institutions, and of our scientific authors, overflow with minute and countless details, which perplex the judgment, and which no memory can retain. In vain do we demand that they should be generalised and reduced into order. Instead of that, the heap continues to swell.'" All this is pregnant with truth, but, alas! what does it mean? Is it not equivalent to saying—enough, ye hewers of wood and drawers of water, let us now fashion our materials, and build our scientific temple? Colonel Sedgwick has herein done something in this direction, as may be gathered from a short extract. He says: "When a mason dresses a stone for building, we know that the stone will lose some of its weight. . . . Thus we see that the atom has fared, in the preparation it has undergone for molecule-building, as the stone fares when it is prepared for wall-building. . . . We can perceive that it (the atom) has fared in undergoing preparation for molecule-building much in the same way as a piece of metal sometimes fares at the hands of a smith." The reader who follows in the wake of our author must be prepared for dizzy heights and oppressive depths like these in the murky regions of speculation traversed.

"Common Objects of the Microscope." By the late Rev. J. G. Wood. Second Edition. Revised by E. C. Bousfield. (Routledge.) 1s. An old friend in new clothes. The work of the reviser must have been a task of no mean order to preserve the identity of the original, seeing that it is thirty-six years since the book first appeared, and considering the great strides which have been effected in microscopical science during that period. Nevertheless the volume in its new garb will, we think, more than sustain its former reputation, and continue to play the part of "guide, philosopher, and friend" to thousands of microscopists in their initial efforts to unravel the mysteries of Nature by means of the magic tube. To the four hundred objects figured in the first edition very many new illustrations have been added—especially in the popular department of pond life.

"Newton's Laws of Motion." By Prof. P. G. Tait. (Black.) 1s. 6d. net. Professor Tait offers a rather curious apology for issuing this book. The laws of motion are, of course, of fundamental importance in the study of natural philosophy—"its unique basis," as he says. "Hence the imperative necessity that the student should, to some extent, be his own teacher in this all important special region." True; but at the same time the student must always, and in every subject, "be to some extent his own teacher." In a three-year course of science if "all important special regions" were amplified, as in this case, the student would be appalled at the number of books to be perused and the ground to be traversed. So long as the day continues to be only of twenty-four hours' duration, students having so much to accomplish in a limited time cannot afford to linger over luxuries. If someone would only find a means of slowing down the earth's spin on its axis the sun would not return to the horizon so quickly, and we should then, perhaps, be able to dispense with those books "presented in a form adapted to parrot-like repetition."

"The Wonders of Modern Mechanism." Third Edition. By Charles H. Cochrane. (Lippincott.) Illustrated. 6s. Mr. Cochrane's book is already known as a popular exposition of the scientific researches and engineering triumphs of the nineteenth century, together with a glimpse into the future, aided by inferences drawn from the lines of research upon which great minds are bent. When we mention that all the chief features of electricity, flying machines, submarine boats, canals, bridges, steel making, sugar refining, photography, and a host of other things are dealt with in a volume moderate in size, it will be readily understood that the reader accompanies the author in a balloon voyage, so to speak, and gets only a bird's-eye view of human activity in the busy world below. But it is a very picturesque and instructive view, and we can recommend the book to all those who are familiar, by name, with the marvellous innovations of the age, yet who are too busy to follow the press in detail.

"Sylvia in Flowerland." By Linda Gardiner. (Seeley.) Illustrated. 3s. 6d. An attempt to popularize among girls and boys one of the many sciences. The device employed is of the Æsop's Fables order; the foxglove, nettles, bees, spiders, and other occupants of the garden, are invested with the power of speech. Some beautiful plates by H. E. Butler adorn the text. "Beauty and the Bee," "Plants on Tour," "Ten Little Rose Plants," "Jumping Seeds," are titles of chapters which speak for themselves. A laboured effort to make the plants tell their own story is often too obtrusive. We should like to see more of that naive element, which tends to conceal the real motives of the actor, infused into the author's style.

"A Manual of Zoology." By the late T. Jeffery Parker, D.SC., F.R.S., and William A. Haswell, D.SC., F.R.S. (Macmillan.) 10s. 6d. The general plan of this manual is similar to that followed in the large "Text-book of Zoology" by the same authors, which has already been reviewed in these columns. The present volume provides a course of work in zoology suitable for students preparing for the highest school examinations or for preliminary university work. The authors wisely decided to restrict the range of subjects by neglecting certain classes of existing animals and omitting references to extinct genera. Similarly the subject of embryology is only lightly touched upon. The text is accompanied by about three hundred beautiful illustrations, some of these, showing the circulation in different types, being coloured in red and blue. Starting with the phylum Protozoa, the Rhizopoda are first described, the Mastigophora, the Infusoria, and the Sporozoa being then taken in order. After a section dealing with the general characteristics of the Metazoa, separate chapters are devoted to the chief phyla from the Porifera to the Chordata. The treatment is explicit throughout, and the book is sure to gain a wide popularity.

"Experiments on Animals." By Stephen Paget. With an Introduction by Lord Lister. (T. Fisher Unwin.) 6s. There are two sides to every question, and very often popular sentiment is on the wrong side. While it is difficult to come across a person who in a case of painful emergency is unwilling to take every advantage of the most recent expert opinion, it is unfortunately quite easy to discover people—more especially people distinguished in walks of life other than scientific—who make a duty of denouncing and disparaging the self-denying work of an army of devoted physiologists who ungrudgingly devote their energies, and in many cases their chances of wealth, to the work of scientific experimenting having for its object the conquest of all the physical ills to which human flesh has up to the present seemed to be the natural heir. And in this work of denunciation, ignorance and misrepresentation often play a very large part. Knowing this we heartily welcome Mr. Paget's little volume. It will now be possible for the earnest man or woman who comes within the sphere of influence of the enthusiastic and ill-informed popular exponent of modern researches, in which experiments on animals take a part, to learn the actual facts of the case, and we may expect that the ubiquitous agitator will no longer have the simple task of rousing indignation in the popular mind by distorted and erroneous accounts of what is being done. Mr. Paget's twelve years' work as Secretary to the Association for the Advancement of Medicine by Research have afforded him unique opportunities to become conversant with such investigations, and that he has fully availed himself of his chances Lord Lister's introduction amply testifies. We trust the book will soon become widely circulated and carefully studied by those persons who have been led to believe that our leading physiologists revel in experiments remarkable only for wanton cruelty and the absence of useful results. Mr. Paget's book is just what was necessary to disprove such statements to the satisfaction of all persons amenable to reason.

"Telephotography: An Elementary Treatise on the Construction and Application of the Telephotographic Lens." By Thomas R. Dallmeyer, F.R.A.S. Illustrated. 15s. net. (London: Wm. Heinemann.) Little has been written about telephotography, and nothing has before appeared comparable to this eminently scientific treatise. It was not until the year 1891 that workable telephotographic instruments were designed, and that designed by Mr. Dallmeyer was the only one in this country. Since then much has been done, and photographers who are provided with a good bellows camera and portrait lens can, by fixing a tele-attachment to their lens, obtain a very considerable magnification. In this book Mr. Dallmeyer treats the subject in a full and masterly manner. Beginning with elementary facts regarding the properties of light and the formation of images in a camera by means of a pin-hole, he shows the effect on rays of light in their passage through a lens. Then, by explaining the elements of a positive and a negative lens, the author demonstrates the practicability of forming an enlarged image by a combination of the two. In other chapters the improved perspective rendering given by the telephotographic lens is dealt with and its practical applications are described. The illustrations are excellent, and include such different subjects as sun-spots, glaciers ten miles distant, architecture, and natural history. By placing an ordinary photograph by the side of a tele-photograph, the two great advantages of the latter are clearly shown, namely, large magnification and true perspective. The only fault we have to find with the work is that mathematical formulæ are too much in evidence. The book is well worth reading, not only by the students of this interesting subject, but by all who intend making use of the telephotographic lens.

"On the Theory and Practice of Art-Enamelling upon Metals." By Henry Cunynghame, M.A. (A. Constable.) 6s. net. Our national workshops, says the author of this attractively produced volume, are becoming filled with "hands," not men. Unfortunately one of the prices we have to pay for the wonderful development of machinery, which will always be pointed out as one of the most remarkable characteristics of the passing century, is the sacrifice of initiative on the part of the individual workman. Where a man has, day by day, to give his whole attention to some single step in a long series of processes through which an article passes during its manufacture, there is little opportunity for him to develop originality—that prime necessity for the true art-craftsman. One of the consequences of these tendencies is the introduction of the sorry substitute—stamped metal—for making jewellery, a practice which, as Mr. Cunynghame points out, deprives modern work of most of its artistic value. Imbued with the laudable desire of placing within the reach of the workman the information necessary for the making of enamels, the author has collected much valuable material on this interesting branch of technology. As Mr. Cunynghame has studied German, French, and Italian authorities, as well as books in English, and in addition is a practical worker in enamels, his book cannot fail to be useful. The volume is clearly printed and lavishly illustrated.

"Babylonians and Assyrians. Life and Customs." By the Rev. A. H. Sayce. (Nimmo.) 5s. net. "There is nothing new under the sun," is the ejaculation which rises to the lips after the most cursory glance at Prof. Sayce's interesting book. Many persons regard letter-writing as a modern invention, and speak as if the correspondence of Cicero and Pliny represented the earliest examples of what is at present very commonly considered a plague. Yet in the volume before us we can read of the private correspondence of a prince who took part in the campaign against Sodom and Gomorrah! Moreover, the original documents themselves, written on clay, have been found, and one of them rests in the Museum of Constantinople! That we could possess the autograph letters of a contemporary of Abraham is, indeed, what Prof. Sayce calls a romance of historical science. Again, everybody surely regards the present status of women, with their high school and university training, as at least a consummation on which we moderns have a right to congratulate ourselves. Yet the ladies of Babylon could read and write as well as the men, and the women were in other respects on an equal footing. One or two letters from the hand of a lady of Babylon show, too, that she took an active part in politics. In the present time of intellectual activity in this country, the chapter dealing with the education of the Babylonians is of especial interest. Girls shared in the education given to their brothers. The instruction imparted was in many respects similar to that which is common in modern schools. Copy-books with head-lines were known; one of the copies states "He who would excel in the school of the scribes must rise like the dawn." Reading books were in use. Geography, literature, grammar, spelling, all were taught; and judging from the minuteness of some of the cuniform characters, and the magnifying glass which Layard discovered at Nineveh, short-sight was a familiar defect. Considerations of space forbid other examples, but equally interesting ones could be multiplied indefinitely. Prof. Sayce's book is as fascinating as it is scholarly, and we heartily advise our readers to obtain it.

Messrs. Thornton and Pickard (Altrincham) send us their catalogue of photographic appliances. That the shutters made by this firm are still the finest in the market is fully borne out by the continued public appreciation of them. We would draw attention to the focal-plane shutter, which is an ingenious piece of work—an adjustable slit in the roller blind makes exposures of from one-twentieth to-one thousandth of a second possible.

BOOKS RECEIVED.

The Story of Life's Mechanism. By H. W. Conn. (Newnes.) 1s.

The Principles of Mechanics. By Heinrich Hertz, translated by D. E. Jones, B.SC., and J. T. Walley, M.A. (Macmillan.) 10s.

Malay Magic. By Walter William Skeat. (Macmillan.) Illustrated. 21s. net.

The Witness of Creation. By M. Cordelia Leigh. (Jarrold.) Illustrated. 2s. 6d.

Journal of Researches. Vol. II. By Charles Darwin. (Ward, Lock.) 2s.

A Book of Whales. By F. E. Beddard, F.R.S., (Murray.) Illustrated. 6s.

Text-Book on Palæontology. By Karl Von Zittel, translated by Chas. E. Eastman, PH.D. (Macmillan.) Illustrated. 25s. net.

Matriculation Directory. No. XXVII., January, 1900. (Clive.)

The Practical Electrician's Pocket Book and Diary, 1900. (Rentell & Co.) 1s.

The Railways of England. Fifth Edition. By W. M. Acworth. (Murray). Illustrated. 10s. 6d.

Artificial Wood in Decoration; Stained and Leaded Glass; Marquetry; Church Decoration. Useful Arts and Crafts Series. (Dawbarn & Ward.) 6d. each.

Church Decoration (Temporary). No. 14 of "Useful Arts and Handicrafts Series." (Dawbarn & Ward, Limited.) 6d.

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Thrush's Nest made of Moss.—On February 4th, while out ferreting for rabbits, I saw a last's year's thrush's nest of an emerald green colour. It was made entirely, except the mud lining, of the beautiful bright moss that abounded on the trunks of the ash saplings around. One day last month, in this same cover, my host saw 13 brown owls fly off one tree.—Jos. F. Green, Benacre Hall, Wrentham.

BEWICK SWANS IN SUFFOLK.—On February 3rd, a keeper informed us a herd of wild swans were on Benacre Broad, so my host, his son, and myself went down there with guns and opera-glasses. We counted seven, and as one appeared to be wounded we shot it. It was Bewick's, and measured 6 feet 2 inches across wings, 4 feet total length, but only weighed 9 lbs., owing no doubt to having in some way been wounded. Until we disturbed them they were making a loud, short, barking noise, and pulling up weeds from the bottom of the broad which the coots around them seemed to enjoy very much. Of course the smaller size of Bewick's swan will always define it from the whooper, but when only one of the two species is to hand, and no scales, the orange patch on the base of the bill, stopping at the nostrils in Bewick's, and continuing on, in an oblique line, in the whooper, will readily show the difference. I have noticed that paintings represent both these swans with black marginal rims to their eyes, like the mute swan, whereas they are really orange.—JOS. F. GREEN.

KITE IN KENT.—On the 23rd of November, 1899, a kite, Milvus regalis, 6 feet across the wings, was shot by a keeper at Swinyfield Miller, 2½ miles from Folkestone. It was on a hare. It had been noticed in the locality for about a month, and mistaken for an eagle.—JOS. F. GREEN.

Yellow-billed Cuckoo (Coccyzus americanus) in Wales. (*Ibis*, January, 1900, p. 219.) Mr. George Dickinson, in a letter to the *Ibis*, says that a specimen of this American species was picked up dead at Craig-y-don, on the shores of the Menai Straits, on November 10th, 1899. This is the seventh occurrence of this species in various parts of the British Islands, but it is scarcely possible that any of them arrived here from America of their own accord. They have all, without doubt, escaped from confinement, probably on board ship.

Rough-legged Buzzard near Londonderry. (*Irish Naturalist*, February, 1900, p. 50.) Mr. D. C. Campbell records that a male of this species was shot by Mr. W. Kilpatrick, at Campsie, near Londonderry. This is apparently its second occurrence in Co. Derry, and the eleventh in Ireland.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

ASTRONOMY WITHOUT A TELESCOPE.

By E. WALTER MAUNDER, F.R.A.S.

II.—THE ZODIACAL LIGHT.

ON the strict principle of order, the Zodiacal Light should not come first amongst the subjects which I propose to take up in this series of papers, yet as the time of the year has come round when the Light is best seen it may be well to neglect the question of strict order and give it precedence.

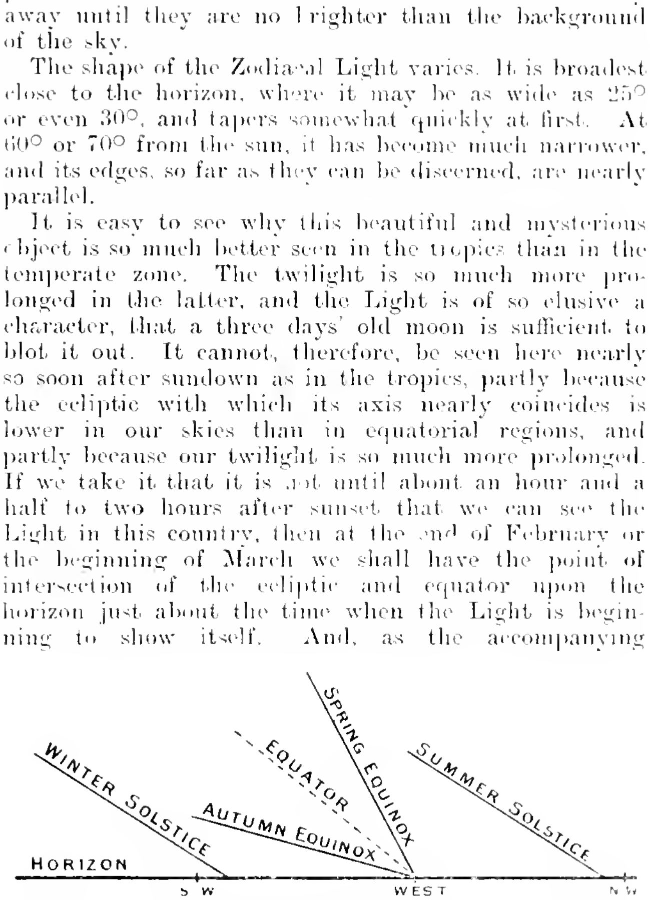
The earliest English description of the Zodiacal Light of which I know was given by Dr. Childrey at the end of his Britannia Baconica, published in 1660. It is as follows:—

"There is a thing which I must needs recommend to the Observation of Mathematical Men, which is that in *February* and for a little before and a little after that Month (as I have observed several Years together), about 6 in the Evening, when the Twilight has almost deserted the Horizon, you shall see a plainly discernible way of the Twilight striking up towards the *Pleiades* or Seven Stars, and seeming almost to touch them. It is to be observed any clear Night. There is no such Way to be observed at any other time of the Year that I can perceive, nor any other Way at that time to be perceived darting up elsewhere. And I believe it hath been and will be constantly visible at that time of the Year."

This description of the Zodiacal Light is quite sufficiently accurate for our ordinary English experience. In the tropics, however, it is seen far more constantly, and attains a brilliancy and distinctness of which we seldom have any example here. There not only during spring, but more or less during the whole year, if the western sky be watched after sunset as the twilight fades out, it will be seen that the twilight which at first seemed to be a pretty regular arch in the west, begins to show a tongue of somewhat greater brightness, which becomes clearer and clearer as the background of the sky around becomes darker, until at length it stands out defined as a great nebulous patch of light, broadest and brightest near the horizon and fading gradually away to the right and left and towards its apex. At its brightest part, and when best seen, it often much outshines the Milky Way by as much perhaps as a couple of magnitudes—that is to say, about six times; or about as much brighter than the Milky Way as the latter is in excess of the average brightness of the sky. But such a degree of brightness is confined quite to the centre of the light and to the portion nearest the sun; its borders melt indefinitely away until they are no brighter than the background of the sky.

The shape of the Zodiacal Light varies. It is broadest close to the horizon, where it may be as wide as 25° or even 30°, and tapers somewhat quickly at first. At 60° or 70° from the sun, it has become much narrower, and its edges, so far as they can be discerned, are nearly parallel.

It is easy to see why this beautiful and mysterious object is so much better seen in the tropics than in the temperate zone. The twilight is so much more prolonged in the latter, and the Light is of so elusive a character, that a three days' old moon is sufficient to blot it out. It cannot, therefore, be seen here nearly so soon after sundown as in the tropics, partly because the ecliptic with which its axis nearly coincides is lower in our skies than in equatorial regions, and partly because our twilight is so much more prolonged. If we take it that it is not until about an hour and a half to two hours after sunset that we can see the Light in this country, then at the end of February or the beginning of March we shall have the point of intersection of the ecliptic and equator upon the horizon just about the time when the Light is beginning to show itself. And, as the accompanying



Inclination of the Ecliptic when the Equinoctial and Solstitial Points are on the West Horizon.

diagram will show, the angle which the ecliptic makes with the horizon is greatest at this time of the year; so that the Zodiacal Light rises up more abruptly into the sky than at any other time, and its brightness is therefore least affected by the absorption of the lowest strata of our atmosphere.

Although the Zodiacal Light has been more or less under observation for some three centuries,—the great Kepler having carefully observed it, with the result of convincing himself that it was the atmosphere of the sun,—the nature of the Light still remains more or less of a mystery. We do not know yet whether it lies in the plane of the ecliptic, or of the sun's equator, or between the two, or whether even its plane may not shift from time to time. It seems to vary in brightness, both according to the season of the year, and from one year to another, but the determinations of its brightness are usually far too vague and rough for any definite period to have been yet fixed for its changes.

So that we have in the Zodiacal Light the great anomaly of a vast astronomical object requiring no observatory and no telescope for its observation; and not only requiring none but permitting none; and yet to-day, when astronomy has lasted 5,000 years, we are still in ignorance of many of the most fundamental facts respecting it.

This is due without doubt to the difficulties which attend its observation. Not that those difficulties are in the least insuperable, but they are very real. We will suppose that someone has noticed the Light for the first time, and desires to make a record of what he sees. It at once strikes him that a mere eye-sketch of it is of very little good indeed; he must place it with respect to the stars. In all probability most of those which would be naturally used to define the outline of the Light are unfamiliar to him. He has therefore to have recourse to the star atlas. He painfully identifies the stars one by one, but each recourse to the atlas, which must necessarily be examined in the Light, dazzles his eyes for his open-air work. He finds, therefore, that the process of recording what he has seen is a very slow and tedious one, and, dissatisfied with what he has done, speedily gives up the work. So that it happens that the names of the men who have done really useful work in this field may be counted almost on the fingers of one hand.

Yet this difficulty can be surmounted without much trouble. First of all and beyond everything, he who would become "an astronomer without a telescope" must learn his stars. They form the very alphabet of the language which he has to learn, and a little trouble spent here will soon repay itself. Next, the difficulty of recording his observations in the dark may be got over in several ways. It is possible to learn to write in the dark with sufficient clearness, and such little dodges as having sets of cards prepared, ruled with lines made by drawing a penknife across the back of the card and cutting it partly but not entirely through, will be found helpful. Or the note book may be placed so that the rays from a ruby photographic lamp may fall upon it. If the eyes are carefully screened from the direct light of the lamp, it will be found that the page may be lighted up quite sufficiently for the purpose of writing without the sensitiveness of the eye to the faint Zodiacal glow being much affected. If a chart is needed for comparison with the sky this might be done by tracing the map of the region required from some star atlas on to a piece of thin cardboard and pricking little holes for the stars. A lamp can be used behind the card to show these, or a piece of card painted with luminous paint might be placed underneath. Many similar dodges for getting over this initial difficulty will suggest themselves to those who seriously take up the work.

But it will be objected, since the Zodiacal Light is seen so much better in the tropics than here, what is the use of trying to observe it in England? There is great use. Take for example one question; the question of its variability in brightness from year to year. In a way this could be as definitely determined from observations made in England as from those made in any other single country. A careful record year by year for a term of years of the number of days when the atmospheric conditions were favourable, and when the Zodiacal Light was well seen, seen faintly, or not seen at all, would soon show as to whether there was any periodicity in its variation, and, if so, whether it varied with the sunspot cycle or not: just as Hofrath Schwabe's record of the days when the sun was seen to be free from spots in each year was quite as effective in determining the sunspot variation and the length of its period as exact measurements of the areas of all the spots would have been. In a certain sense our less favourable position would serve as a kind of photometer of the brightness of the Light, and our very hindrance might transform itself into a help.

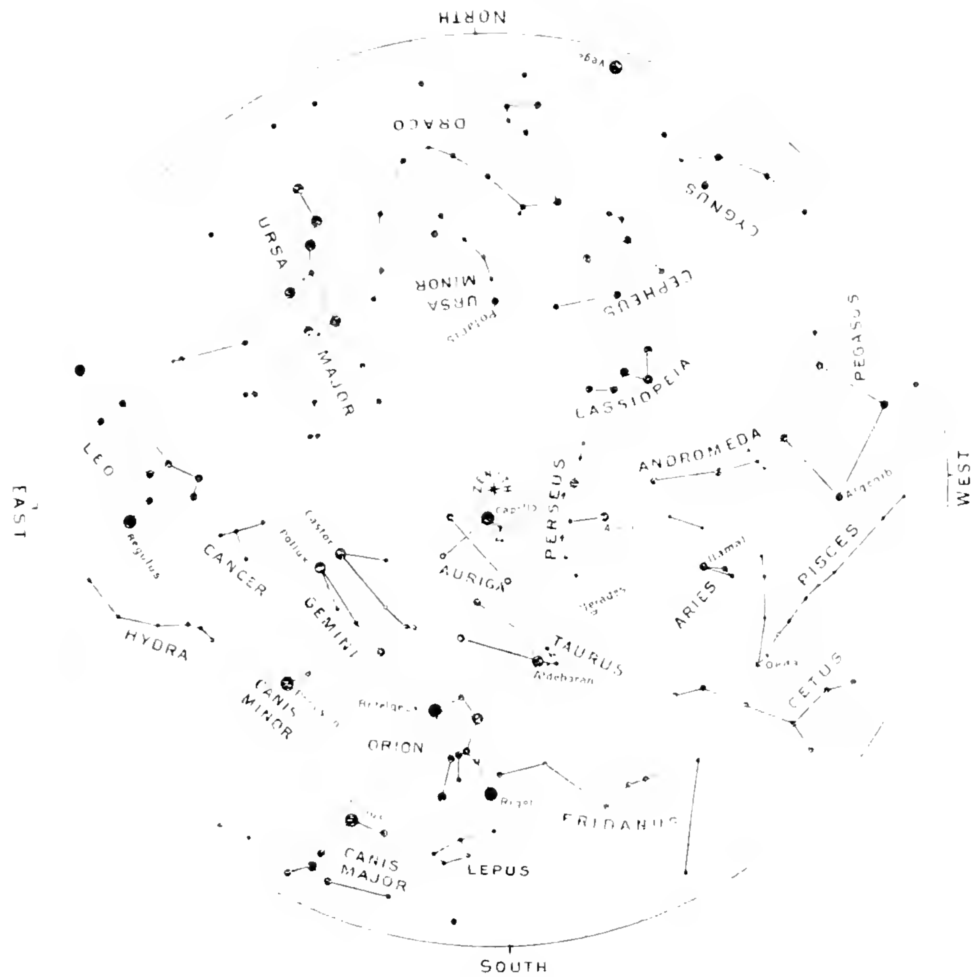
Then, a more important point, observations in one latitude alone are not sufficient. We want to ascertain, either what is the amount of parallax which the Light shows or else that it has no perceptible parallax at all. Then, the degree to which its apparent outline is affected by atmospheric absorption is even more important, as otherwise we cannot tell whether an apparent shift in its plane is real or not. For both these enquiries it is necessary that observations should be made in several distinct latitudes. It is for this purpose that, in 1898, the British Astronomical Association initiated a Zodiacal Light Section, in order to enlist the co-operation of observers in many lands, under the directorship of Captain P. B. Molesworth, R.E., Trincomali, Ceylon, who has prepared a set of eight ecliptic charts to assist in the study of the Light.

The principal points for observation in Zodiacal Light work are, first of all, to note the character of the evening. The magnitude of the faintest stars visible in the west should be recorded. The visibility of the Milky Way, and the distinctness with which its rifts and streamers can be made out, would be most useful for comparison. The evidence must be clear that there is no mist or dust veil to hinder observation, and here, it may be added, that the dwellers in towns are necessarily too severely handicapped to enter upon this class of work. The smoky atmosphere and the glare of street lights are fatal to so delicate a research.

The Light itself should then claim attention. It will be perhaps easiest, first of all, to map out its extreme border, and this will often be best detected by looking a little way from the Light; "partially averted vision" having a distinct advantage for very faint objects. Then a definite area of the Milky Way may be taken as a standard, and, so far as possible, the outline of the Light where its brightness equals that of the selected area of the Milky Way should be laid down. Search should be made in the part of the ecliptic immediately opposite the sun to detect the Gegenschein or Counterglow, the faint diffused light which travels through the heavens in opposition to the sun. It should be seen whether the Zodiacal Light extends to, and is merged in the Counterglow, or whether there is a space of dark sky between them; and here it will be found useful to take for reference some of the darkest regions of the sky which may be available. The position of the apex of the Light is very important, and at this season of the year it should be especially noted whether the Light can be definitely traced beyond the Pleiades. There can be no doubt that that group does seem to exercise a strong attractive influence upon the Zodiacal Light, probably apparent only, but on that account the exact position of the apex relative to the cluster is worthy of the very strictest attention.

Keen eyesight, patience, and a small star-atlas are, therefore, all the equipment that is required for Zodiacal Light work. The description of the work may not seem inviting, yet when once it is taken up the looking for that strange, beautiful, yet faint and elusive glow will be found full of interest, and the more its peculiarities are followed up, the more will the sense of its mysteriousness be realized, and the greater will be the desire to contribute something which may explain its secret.

heavens. Facing round the west we notice low down four stars placed at the angles of a great square in the sky. The square of Pegasus. At this moment the square is, as it were, balanced on one of its points, and the point furthest round to the left as we face it is marked by Gamma Pegasi, the star Algenib. A straight line from the Pleiades to Algenib passes through Alpha Arietis, Hamal, the brightest star in the Ram. Hamal is nearly midway between the Pleiades and Algenib, but a little nearer the former. Two stars, as shown in the diagram, near Hamal, make with it a characteristic little figure, a small triangle with a very obtuse angle. These are Beta and Gamma, the other stars in the Ram's head.



The Heavens at 6.30 p.m. on March 6, from the Latitude of London.

The constellations through which the Zodiacal Light runs at the beginning of March are those of Pisces and Aries, right up to the Pleiades on the borders of Taurus. Neither of these two constellations are at all conspicuous, and they are therefore not the best with which to begin a study of the constellations, but they may be picked out without much difficulty by noting their near neighbours.

At this season of the year the Pleiades, "glittering like a swarm of fireflies tangled in a silver braid," have just passed the southern meridian and are still very high in the sky. They are known to everyone, nor is there any possibility of mistaking them, since they form the compactest little cluster in the whole

If we draw a straight line downwards from Hamal at right angles to that joining Hamal and the Pleiades and equal to it in length, we come to Alpha Piscium or Okda, meaning the "knot of the two threads." The reason of the name can easily be recognized, for two irregular lines of somewhat faint stars both meet together at Okda, the one runs from Okda to the right nearly parallel to the horizon at first and then bending down towards it, the other curving somewhat upwards, also to the right. These two streams make up the bulk of the constellation of the Fishes, and it is across the two constellations of the Fishes and the Ram that the evening Zodiacal Light streams upwards toward the Pleiades at this season of the year.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE EARWIG AS A BENEFACTOR.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Our common earwig (Forficula auricularia) is usually thought to be an unmitigated nuisance to the gardener; it is considered destructive to fruit, it damages dahlias, and is supposed to have a weakness for exploring the cavities of the human ear.

Its scientific reputation is better; it was found to be carnivorous, preferring dead insects to fruit or vegetable food, and it has the amiable habit not hitherto observed in other insects, of brooding over and rearing its young. I have several times mounted the whole insect as a slide for the microscope: one of these shows the food in an undigested state, and I was surprised to find on careful examination and comparison, that the stomach was full of Aphides (green fly, plant lice), in a more or less disintegrated condition. The identification was placed beyond doubt by the discovery of several of the characteristic tubes through which the Aphis exudes the "honey dew." In another earwig I found the scales of a Lepidopterous insect together with the remains of Aphis in a more digested condition.

It is well known that the earwig is nocturnal in its habits, and I would much like to know if any of your readers have actually seen the insect commit the damage it is usually credited with, or if the evidence is purely circumstantial. In any case earwigs must do a certain amount of good by the destruction of the plant lice, and ought to have a measure of that tolerance extended to them that is bestowed, or ought to be bestowed, on the Syrphus fly, the Lady Bird (Coccinella Septempuncta), and the larvæ of the Lacewing fly (Chrysopa), on account of their habit of preying on these pests.

South Hampstead. Walter Wesche.

SOME CURIOUS LUNAR PHENOMENA.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In last week's issue of "Nature" several correspondents are quoted as having sent descriptions of solar halos and parhelia observed from various parts of Sussex and Surrey on Thursday, January 11th, between 9.30 and 11.30 A.M. The following account of an unusual lunar phenomenon occurring on the same day at 5 P.M. may prove interesting. I was driving home from Beddgelert when the moon's peculiar appearance attracted my notice. The moon was just at that moment partly obscured by a thin cloud, but it was plainly visible that surrounding and touching the disc there was a distinct girdle about twice the moon's diameter in breadth. When the cloud passed the sight was beautiful beyond words. The well-illuminated disc had the usual opaque markings—"the man in the moon"—almost in high relief, while surrounding it there was a belt of golden hue, which in its turn was encompassed with a magnificent aureole of many colours, of which red, blue, and violet predominated, the whole showing the moon in the height of its glory.

On the 15th inst. the moon presented a distinctly [illegible] appearance, with a sharp halo surrounding it at an unusually great distance.

In view of the exceptionally wet weather in this district, ever since the 12th inst., it would be interesting to know how far atmospheric influences go to account for such appearances.

Portmadoc, North Wales. Walter Williams, M.B.
January 2[illegible]th, 1900.

THE CONSTITUENTS OF THE SUN.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—With reference to the excellent article on the above subject by Mr. A. Fowler, may I be permitted to make a few remarks with special reference to Fig. 3 accompanying the article? This picture is entitled "A solar comparison, showing how the presence of carbon in the Sun is demonstrated. (1) Carbon flutings in electric arc, with iron impurity. (2) Solar spectrum."

Now an examination of the two spectra pictured here (which I presume are re-productions of photographs) by no means suggests to me an identity with one another. I certainly see that three bright lines in (1) coincide very completely with three dark ones in (2), both as regards appearance and position; but these three lines are apparently due to iron. None of the other (dark) lines in (1) seem to have their counterpart in (2). In fact I cannot see a single satisfactory coincidence. How then can the comparison of the two spectra in question be said to demonstrate the presence of carbon in the sun?

I always understood, especially in earlier days of spectroscopy, that the exact coincidence of many bright lines in a spectrum of a terrestrial substance, both in thickness and in position, with a similar number of the dark Fraunhofer lines constituted an enormously favourable argument for the existence of that substance in the Sun.

Thus we read at p. 246 of Schellen's "Spectrum Analysis" (translated by J. and C. Lassell):—"A glance at Fig. 91, in which the coincidence is shown of more than sixty of Kirchoff's observed lines of iron, with as many dark lines in various parts of the solar spectrum between C and F, justifies the conclusion that those dark lines are to be ascribed to the absorptive effect of the vapour of iron present in the atmosphere of the sun. The likelihood that such a coincidence of sixty lines is a mere chance, bears a proportion to the supposition that these lines really make known the presence of iron in the sun's atmosphere, according to the doctrine of probabilities, 1 to 2/60, or in other words in the ratio of 1 to 1,152,930,000,000,000,000."

The figure referred to in this excerpt, is more or less academical, being a woodcut. The upper portion represents the solar spectrum on a small scale; the lower the spectrum of iron, bright lines on black background. Each dark line of iron in the solar spectrum is continued through the second spectrum as a bright line. As there are 57 of these coincidences (not 65 as stated under the plate), the effect to the eye is most remarkably convincing.

Since the date of this work (1872) great advances have been made in the knowledge of the variations in terrestrial spectra which can be produced under different conditions in the laboratory, and the apparently rigid and exact coincidences formerly laid down must be considerably modified in the light of present knowledge. Without denying the existence of many terrestrial elements in the sun, I would like as a layman and one not versed in the practical study of spectra in powerful instruments to ask Mr. Fowler whether two photographed spectra of an element and of the sun respectively can be produced in juxtaposition so as to show to the eye as complete and convincing a set of coincidences as was given in the woodcut referred to, which was evidently based on measurements only. Or are the lines of any one element in the solar spectrum so intermingled with those of other elements that it is impossible to see the coincidence as a whole? That is, is it only by the comparison of each line, one after another, with its counterpart in the solar spectrum, that the assurance is obtained that the element's spectrum is really contained in and forms part of the solar spectrum?

Devonport. E. E. MARKWICK, Col.

14th January, 1900.

[Unless Col. Markwick has written "dark" when intending to write "bright" in the sentence "none of the other (dark) lines in (1) seem to have their counterpart in (2)," I fear he is labouring under a slight misapprehension. In the case of carbon, as for other substances, its identification depends upon the coincidence of bright lines obtained terrestrially with the dark ones of the solar spectrum. Viewed in this way, a considerable number of the bright lines which build up the carbon fluting, commencing at Lambda 3883, are seen to correspond with dark ones in the sun, and the presence of carbon among the solar elements is clearly demonstrated by the photograph. The apparent dark lines between the bright members of the carbon flutings are simply dark interspaces and naturally do not agree with solar lines.

I may add that photographic demonstrations of the presence of many chemical elements in the sun are just as convincing, and certainly more satisfactory, than the diagram to which Col. Markwick refers, but believing these to be sufficiently well known, I purposely selected an illustration of the detection of a substance requiring more careful investigation. In the case of carbon the component lines are crowded together and in the sun are superposed upon lines belonging to other substances, so that the correspondence is not so obvious as in many other illustrations which might have been given.—A. FOWLER.]

OBSERVATIONS OF VARIABLE STARS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—My estimates of the movement of S. S. Cygni at its last appearance are as follows, viz.:—

1899.	H.	Mag.	1899.	H.	Mag.
Oct. 24.		Invisible.	Oct. 30.	7.45 p.m.	8·65
„ 25.	7.30 p.m.	8·65	„ 31.	7.45 „	8·85
„ 26.	7.30 „	8·35	„ 31.	9.00 „	8·85
„ 28.	7.00 „	8·35	Nov. 1 & 2.	Cloudy.	
„ 28.	8.00 „	8·35	„ 3.	—	10·00 or less.
„ 29.	7.30 „	8·55			

Since August 11 I have seventy-one observations of S. U. Cygni (Muller and Kempf's variable), period 3d. 20h. 15m. 21s., varying from 6m. 57 to 7m. 37, and though at first apparently irregular, experience has shown it to be an evenly moving star, within the range of the field glass at all phases, and an attractive object for amateurs. At the minimum phase it appears on many occasions to remain at the same light for twenty-four hours, and then rise rapidly to maximum. The fact is that in its near approach to minimum and rise from that phase it takes twenty-four hours to fall and to rise, or to change, less than one step 0.1. That is to say when the star reaches about 7m. 31 it takes twenty-four hours to fall to 7m. 37 and rise again to 7m. 34. So one who has no photometer may announce a minimum some time before that phase is reached, or after the star has passed it. This is shown by Prof. Pickering's curve. There have been similar occurrences at maximum more than once, but they have not been observed so often nor have they been so marked.

S. Virginis was an unsteady star at its last appearance; its changes were estimated as follows:—

1899.	Mag.	1899.	Mag.
June 3.	10·00	July 8.	7·60
„ 4, 5.	10·00	„ 9.	7·40
„ 7.	9·40	„ 10, 11.	7·23
„ 14.	9·23	„ 12, 14, 15, 17.	6·95
„ 17.	9·10	„ 22, 23 maximum	6·80
„ 20.	8·50	„ 29, 30, 31.	7·03
„ 25.	8·35	Aug. 1.	7·15
„ 26.	8·30	„ 2.	7·15
„ 27.	8·13	„ 4, 5.	7·25
„ 29.	8·00	„ 6.	7·35
„ 30.	7·90	„ 9, 10.	7·30
July 1.	7·70	„ 11.	7·90
„ 2.	7·90	„ 20, 21.	7·80
„ 3.	7·85	„ 23.	7·87
„ 6.	7·75	„ 27.	8·05

The computed date of maximum was June 26, so the star was 26 days late. The weather during nearly the whole of the summer period was not favourable for observations in the southern skies, and so R. Hydræ being further south was more difficult of observation. The best I could do is appended:—

R. HYDRÆ.

1899.	Mag.	1899.	Mag.
May 31.	7·45	July 10.	6·70
June 1.	7·40	„ 13.	6·65
„ 3.	7·30	„ 14.	6·40
„ 4.	7·15	„ 29.	5·65
July 1-5.	7·10	„ 30.	5·50
„ 6.	7·00	Aug. 1.	5·40
„ 9.	6·80	„ 2, 5, 6.	5·00

The maximum was due August 8, and compared with former appearances is probably late again.

DAVID FLANERY.

Memphis, Tenn., U.S.A.,

18 November, 1899.

IS THE STELLAR UNIVERSE FINITE?

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I have followed lately with great enjoyment, the interesting discussion on this most interesting subject. There is, however, one most fundamental point which has not yet been elucidated, and in connection with this I beg leave to say a few words.

Mr. Burns stated and Mr. Maunder and Mr. Hill have challenged the statement that—"If the number of stars were infinite, we should have the whole sky a blaze of light." The unqualified statement is certainly a bold assumption, and a little careful consideration, combined with a little mathematical analysis, will soon show to what extent the assumption is justifiable.

The problem resolves itself into the integration or summing up of an indefinitely great number of indefinitely small quantities. Will the yield be necessarily indefinitely great? May it not be a finite quantity?

There is a kind of struggle going on between the greatness of the number and their smallness in size.

To take an actual example, if we consider a series of quantities, one, a half, a quarter, an eighth, and so on, each term becoming smaller and smaller, and even if we take an infinite number of terms of this series and add them together the total cannot exceed two. In this case the infinite smallness of the terms has so counteracted the infinite greatness of their number that the total yield is a finite quantity. Now may it not be likewise in the case of an infinite stellar universe? May not the infinite number of the stars be so counteracted by their infinite smallness in apparent size, that, no matter how vast a region of space we consider, the yield of light cannot exceed a definite amount? We are faced in fact with the question which the machinery of the integral calculus has been constructed to answer. What is the value of infinity multiplied by zero? Such a product is called by mathematicians an indeterminate form; indeterminate since its value cannot be ascertained until we know by what process the infinitely great was reached, and likewise the infinitely small. In the particular case before us, the infinitely great was reached by receding further and further into space, which also brought about the infinite smallness of each individual star. A connection clearly exists between the growth in number and the diminution in size, and this connection entirely depends on the manner in which the stars are distributed throughout space. This is a point which Mr. Maunder has made, and it cannot be too strongly emphasized. Without considering first the method of distribution, it is perfectly futile to attack the problem, in fact there is no problem to attack. We must first postulate a particular formation, and then, and only then, can we apply rigid mathematical reasoning.

The formation which naturally occurs to us first, is that of a uniform distribution. This distribution may be obtained by considering the stars distributed on concentric spheres whose radii increase by equal steps. Then the number of stars on any one spherical arrangement would vary as the area of the sphere, but the apparent disc of each star would vary inversely as the area of the sphere, since it varies inversely as the square of the radius. Thus the growth in number would exactly balance the decrease in size, and the luminous area contributed by each spherical distribution would be the same. This contribution is quite finite, therefore by taking enough distributions we can obtain any desired yield of light, enough for instance to completely fill the heavens. The above argument is quite independent of the size or distance apart of the stars, and it leads us to the very interesting fact, that granted the perfect transmissibility of the ether, and non-interference by dark bodies, then no matter how diffused the stars are through space, so long as that distribution is maintained to an infinite distance in all directions, the appearance of the heavens ought to be complete brightness. All we require is that at no region of space shall the density of star distribution become indefinitely small. It may fluctuate, but it must not become ever indefinitely small. Assuming that stars are a million miles in diameter, and spaced uniformly twenty billion miles apart, I find that a region of space, ten thousand trillion miles in radius, would be sufficient to completely fill the heavens with light to an observer at the centre.

Let us now take the case where the stars thin out in numbers as the distance from the earth increases. In order to give numerical results, let us again assume that the stars are all a million miles in diameter, and that those nearest the earth are spaced twenty billion miles apart. If the number of stars per unit volume of space varies inversely as any positive power of the radius, we get a distribution which progressively thins out. We have just dealt with the case in which this index power is zero. When powers other than zero are assumed the problem resolves itself into a simple case of integration. As the powers increase from zero upwards, the rate at which the density of distribution falls off increases, and consequently a greater and greater region of space must be included in order to block every direction with a star. When the index power is unity, or in other words when the density of distribution varies inversely as the radius, this distance is so stupendously great that I am almost afraid to mention it. One followed by twenty billion noughts, and then multiplied by twenty billion, will almost suffice. It is clear we are nearing the law of distribution when it will be necessary to include an infinite region of space in order to occupy all directions with a star. This stage is reached when the index of the power exceeds unity by only one five hundred billionth. If the law of distribution gives an ever so slightly quicker rate of thinning out, we cannot, even by considering an infinite region of space, gather up enough to make the heavens a complete blaze of light.

In fact, all infinite distributions fall into two classes:—

(1) Those in which all directions are blocked by stars,

(2) Those in which interstellar spaces exist;

And the law of distribution which forms a link between these two classes, occurs when the power of the radius very slightly exceeds unity.

When the power is two, interstellar spaces so vastly exceed the luminous area, that only about one forty billionth of the heavens is illuminated. It is very instructive to note how an exceedingly small change in the law of distribution produces an exceedingly great difference in the amount of the heavens illuminated.

There is another question which should be considered in connection with this subject. When we assume a progressively decreasing density of star distribution, might not the same reason, which in some cases makes it impossible to obtain more than a finite amount of illumination, also prevent us from obtaining more than a finite number of stars? The answer is, that if the density varies inversely as the radius raised to a power greater than three, then indeed the number of stars in infinite space will be finite. With a less rapid thinning out the number is infinite.

We have seen that the distances dealt with in connection with this problem are absolutely stupendous; so great, in fact, that the life of a star would be a mere nothing compared with the length of time occupied by its light in coming to us. This brings up the consideration that if such vast regions of space are to be considered then the probability of any one direction being occupied by a bright star is exceedingly remote. In fact, dark stars ought to outnumber bright stars by millions or billions to one. This being true, at first glance one would expect that eclipses of bright suns would be a common occurrence. But a moment's reflection shows, that as far as the visible stars are concerned, the interstellar spaces are so vastly greater than the spaces occupied by bright suns, that dark stars might outnumber them by billions to one without making an eclipse probable. It would only be in the more distant depths of space, depths so profound that our most mighty telescopes could never identify single stars therein, that the blocking out of light by the dark bodies would have effect. For instance, in the homogeneous distribution we first considered, although all directions would be blocked by stars, yet it may be, only an infinitesimal proportion of these are bright stars. This theory for accounting for the black background to the bright stars has not, I think, been brought up in the recent interesting discussion, and it seems to me to be worthy of a place in Mr. Burns' list of possible hypotheses.

Charles E. Inglis, B.A.
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A TODA MAN.

A TODA BEAUTY.

A VEDDA MAN.

A VEDDA WOMAN.

SOME WILD INDIAN TRIBES.

SEAL IN SUFFOLK

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I had a seal (Phoca vitulina) given me to-day that was shot by a coastguard yesterday at Dunwich. It was under a boat on the beach. It was 4 feet long, and weighed 76 lbs.

Benacre Hall, Wrentham, Jos. F. Green.
February 9th, 1900.

SOME WILD INDIAN TRIBES.

By R. Lydekker.

To the great majority of Englishmen (not even excluding a large proportion of those who have made the East their temporary home) the native inhabitants of India and Ceylon are typified by civilised and more or less cultured races, such as the sleek Parsi of Bombay, the studious Bengali Babu, the large-turbaned Madrassi, the haughty Rajput, or the warlike Sikh. And comparatively few are aware of the existence in various districts of both the peninsula and the island of a number of wild tribes, some of whom are little, if at all, better than savages, while others have acquired certain of the arts and practices of civilization. Of all these jungle peoples perhaps the most generally known are the Gonds, who give their name to the great Gondwana country of Central India, and who are some of the best hunters and trackers in the world.

But it is not to them that the attention of the reader is invited in the present article, the greater portion of which is devoted to the wild tribes inhabiting the Nilgiri and Anamalai ranges on the western side of the Madras peninsula, between Travancore on the south and Mysore to the north. In the "Blue Mountains," which is the English equivalent of the name first mentioned, roam the tiger, the sambar deer, and the great Indian wild ox, or gaur, while they are also the home of the now rare Nilgiri wild goat. On the clearances amid the dense and luxuriant primeval forest, or on the open grass-lands of the hill-tops, dwell a number of interesting aboriginal wild tribes, among whom the Todas and the Kotas are perhaps those whose names are the least unfamiliar to European ears. Indeed it is possible that some of my readers, other than Anglo-Indians, may have actually seen a live Toda, since a member of that tribe was formerly with Barnum and Bailey's show, during the life time of "Jumbo"; this individual, after his return to his native jungle, posing as an authority among his fellows on all foreign matters. Recently the various wild tribes of the Madras hills were the subject of a special study by my friend Dr. Edgar Thurston, Director of the Madras Museum, the results of his investigations being published in a series of interesting and well illustrated memoirs issued by the Museum. It is from these memoirs that the following information regarding the characteristics of these people is chiefly culled.

With regard to the affinities of the Todas and their kindred, it seems quite evident that they have nothing to do with either Negroes or Australians; while, although some have thought that they may retain certain traces of a Mongol strain, it is perfectly clear that they cannot be classed among that great section of the human race. On the other hand, they evidently appear to belong to a low type of the noble Caucasian stock, and may be affiliated to the great group of Dravidian-speaking peoples, who probably populated a great portion of India previous to the incursion of the higher Aryan hosts from the northward.

Physically the Todas are decidedly a fine race, the men standing rather above the medium height, and the members of this sex differing markedly from all the neighbouring hill tribes by their [illegible] handsome, and almost classic features, which have, indeed, been compared to the Ancient Roman type, though in certain instances they display a somewhat Jewish cast. But the most characteristic feature of these people is the luxuriance of raven-black hair on the [illegible] face, although this great hirsute development is [illegible] marked than in the Ainus of the Island of Yezo, who [illegible] likewise appear to belong to the Caucasian stock. As is excellently shown in the accompanying illustration, the men wear the hair parted in the middle, and hanging down almost or quite to the shoulders. In the men, the colour of the skin is a dirty copper brown, much darker than that of the women, which has been described as of a cafe-au-lait tint on the chest and limbs. When young some of the women, who dress their hair in glossy ringlets, are decidedly good looking; their glistening eyes and white teeth forming good points, although the rest of the face is spoiled by the rather large mouth and thick lips. But even such claims to beauty as a Toda maiden possesses are but transient, and the girl soon degenerates into a hideous hag. One other noteworthy feature of the Toda men is the great development of the brow-ridges, which communicates a somewhat scowling expression to the forehead, likewise well exhibited in the photograph.

The latter also displays the dress of the men, which consists of a garment of thick cotton cloth, with interwoven stripes of red and blue, hanging in graceful folds from the shoulders to the knees, and having one end thrown over the left shoulder. The women's outer garment is of the same simple type, but is thrown over both shoulders, and grasped in front by the hand. Every native race, it is said, has a distinctive and recognisable odour of its own, and this is certainly verified in the case of the Todas, in which this odour is by no means grateful to European nostrils. It is said to be mainly due to the rancid butter, or ghi, which they are in the habit of applying to their clothes for the purpose of preserving them.

Being thus well clothed, the Todas can scarcely be reckoned as savages; and under missionary instruction they learn to read and write without much difficulty. They never carry, and indeed apparently do not possess, arms of any kind, being an essentially pastoral people, living chiefly on the milk and butter derived from the herds of buffaloes they keep. They have many more or less noteworthy customs, some of which are declining, and tending to die out under the civilizing influences of the British Government. Formerly, female infanticide was extensively practised, with the natural result that the numbers of the women were greatly inferior to those of the opposite sex. Consequently, polyandry was the general custom; and although there is now, owing to the abolition of infanticide, no need for this peculiar practice, yet it is still retained among some of the poorer members of the tribe, who are, however, extremely loth to acknowledge its existence.

In view of the fact that so many aboriginal tribes tend to dwindle in numbers, if not to disappear altogether, when brought into contact with [civilising] influences, it is interesting to learn that this is not the case with the Todas, who during the last [thirty] years have shown a tendency to increase; their numbers being six hundred and ninety-three in 1871, six hundred and seventy-three in 1881, and seven hundred and thirty-six ten years later. Previous to marriage, which is regarded as binding, the morality of these people cannot by any means be described as of a high grade: and when any advantage is to be gained by stating a falsehood, no Toda considers himself bound to adhere to the truth. As already said, Todas are a pastoral people, and they display a rooted antipathy to manual labour of any description. So strongly is this trait developed, that in the case of a convict, the gaol authorities, finding it impossible to make him work without resorting to severe measures, solved the difficulty by appointing him an overseer. This is clearly an instance where idleness paid.

Todas dwell in small villages, or hamlets, each of which is called a mand, and usually includes five buildings: three of the latter being used as habitations, while the fourth forms a "dairy-temple," and the fifth a calf-pen. These huts are generally about eighteen feet in length by ten in height, and nine in width ; the interior being from eight to fifteen feet square, and of sufficient height to permit a man to move without knocking his head against the roof. They are neatly built of bamboos, fastened with rattan and thatched ; the arched roof reaching the ground at the sides. The ends are closed by wooden panelling, placed within the margins of the roof. "The entrance, or doorway, measures," according to Dr. Shortt's account, "thirty-two inches in height and eighteen inches in width, and is not provided with any door or gate, but the entrance is closed by means of a solid slab or plank of wood, from four to six inches thick, and of sufficient dimensions to entirely block up the entrance. This sliding door is inside the hut, and so arranged and fixed on two stout stakes, buried in the earth, and standing to the height of two and a-half to three feet, as to be easily moved to and fro. There are no other openings or outlets of any kind either for the escape of smoke, or for the free ingress and egress of atmospheric air. The doorway itself is of such small dimensions that to effect an entrance one has to go down on all fours, and even then much wriggling is necessary before an entrance is effected." Needless to say when the visitor has succeeded in passing the barrier he is not impressed by the freshness of the atmosphere of the interior ! On one side of the interior is a raised platform covered with deer-skins, and used as a sleeping place, while the fire-place is opposite.

There are many curious ceremonies on the occasions of birth, marriage, and death, of which space does not admit of mention, and I accordingly pass on to say something concerning the dairy-temple, or tirieri. It must be premised that the religion of the Todas is a simple primitive faith, superadded to which is a large strain of Hinduism; and to this latter is due the cult of the cow, here represented by the buffalo.

In addition to the dairy-temple in each mand, there are certain special settlements of this class, each of which is supervised by a couple of black-clad monks or palals, while the work of the establishment is carried on by two herdsmen, or kaltamaks. Such an establishment comprises one hut for the palals, a second for the kaltamaks, a large and a small cattle-pen for the sacred herd, and the temple itself ; the latter containing the sacred bell or mani, and the dairy apparatus. The most sacred member of the herd is the bell-cow, whose office descends to the eldest female off-spring, failing which a cow is imported from another tirieri. A palal must be a bachelor ; and it is his duty to send the herd out to graze, to salute them on their departure and return, to make butter, and to offer prayers. Truly a somewhat mixed order of functions. No one but a palal or a kaltamak is permitted to enter the sacred enclosure ; but one of the former is accustomed at certain times to bring butter and milk outside the establishment for sale to the ordinary Todas or their neighbours the Badagas. Superfluous bulls from the herd become the perquisites of the kaltamaks, by whom they are sold to Todas or Badagas. Of such animals as die the flesh is, however, given to the tribe of Kotas, who are carrion-eaters, and have no prejudices as to the sacred character of the cow and its kindred.

It is from the aforesaid Kotas that the Todas acquire their iron axes and knives, as well as their earthenware utensils ; the flesh, horns, and hides of the deceased buffaloes being the quid pro quo. The Todas consider themselves vastly superior to either the Kotas or Kurumbas, both of which are neighbouring hill-tribes. When a Kota meets a Toda, he acknowledges the superiority of the latter by kneeling down and raising his foot to his own head. On the other hand, when a Toda encounters a Kurumba the latter bows, and is patted on the head by the former.

The Kotas (literally mountaineers), who number a little over a thousand individuals, inhabit seven villages in the Nilgiris, one of which is situated in the Wynad district. They build huts of mud, wood, or stone, roofed with thatch or tiles, and divided into living and sleeping apartments ; the huts themselves being arranged in long streets. As already said, the Kotas are carrion-eaters, and there are few more disgusting sights than to see one of these men carrying part of a decomposed buffalo to his home. They are also hard drinkers, and have no caste. Their redeeming quality is that they are excellent artificers, catering for the wants of all the neighbouring tribes. They are excellent blacksmiths, and make very serviceable axes, knives, etc. Formerly they smelted the iron-ore of the country, but now purchase scrap-iron brought up from the plains. They are likewise good practical agriculturists.

Unlike the Todas, who never hesitate to meet Europeans frankly, the Kota women bolt into the jungle at the sight of a white face. And as they are filthily dirty and by no means handsome, this is perhaps no great disadvantage. The men are much less good looking and also less hairy than the Todas, wearing their thick wavy hair parted in the middle and tied in a knot behind, while they trim their beards short and wax their moustaches. Both men and women wear bangles. They are a light-hearted people, enjoying dances and other tamashas.

Of such others of the Nilgiri tribes as can be mentioned at all, our notice must be of the briefest. The Kurumbas, who populate much of the Wynad district, are the great woodcutters and collectors of forest produce of the region. In 1870, Col. King gave the following not over-pleasing picture of the Kurumbas :— "Their chief food is wild roots and berries, or grains soaked in water, with occasional porcupines and polecats. Their dwellings are nothing more than a few branches piled up together like heaps of dead brushwood, in a plantation, often simply holes or clefts among the rocks. Their clothing is, with the males, a small dirty cloth round the loins; and with the females, a rag thrown on any way that its condition and size render most available. The appearance of these rude people is wretched, and even disagreeable. Low in stature, they are also ill-made; the complexion is of an unhealthy hue, and their heads are thinly covered with mangy-looking hair. They have bleared eyes, a rather wide mouth, and often projecting teeth. Spare to leanness, there is also a total absence of any apparent muscle, and the arms and legs are as much like black sticks as human limbs. No such ceremony as marriage exists among these people, who live together like the brute creation." With the opening-up of the Wynad as a coffee-growing district, the condition of the Nilgiri Kurumbas, who are employed as labourers, has considerably improved, and therefore the above picture is of all the more value. But, with their dark skins and broad noses, they are still a low-grade people; and as such to be distinguished from the light-skinned, aquiline-nosed Ura Kurubas of Mysore.

Of an equally low grade with the Nilgiri Kurumbas are the Kadirs of the Anamalai Hills, and the range extending thence into Travancore. They are especially characterized by their comparatively short bodily stature, the very dark colour of the skin, the breadth and flatness of the nose, and the somewhat thickened and protruding lips. In spite, however, of these distinctly Negro-like features, the Kadirs display their affinity with the Caucasian stock in their curly, as opposed to woolly, hair, as well as by the absence of decidedly projecting jaws. A Kadir may also be recognized at the first glance by reason of the curious custom of chipping the front teeth, which is universally practised by the members of both sexes.

Nearly allied to the Kurumbas are the Kulas of the Nilgiris; indeed, so closely do the members of these two tribes resemble each other that the managers of coffee estates are unable to state definitely how they distinguish between them. Leaving then the Kulas with this bare mention, we pass on to the distinctly higher Badagas (Northerners) of the Nilgiris, of whom there were twenty-nine thousand odd in the last census, against a little over twenty-four thousand in the previous enumeration. As the Todas are the pastoral, and the Kotas the artizan population of the Nilgiris, so the Badagas are the agriculturists of the region. They live in large villages, generally situated on some low hillock, and comprising rows of well-built and well-roofed houses, surrounded by fields of millet and other grain. They are also well dressed, and as their religion and other customs are of the Hindu type, they scarcely come under the designation of wild tribes, and may accordingly be dismissed without further mention.

Passing into Ceylon we find, however, a tribe of thoroughly wild people in the Veddas, who are decidedly lower in their physical characters than any of the Indian Dravidians, and whose customs certainly do not give them claim to any higher position. In stature the Veddas are unusually small, the height of the men averaging only five feet two inches, and of the women not more than four feet ten inches. Although the exact shade varies somewhat on different parts of the person of the men, the general colour of the skin is dark brown. In person the Veddas are strongly built, but they show distinct evidence of a low grade in the excessive relative length of the limbs, long arms being a distinctly ape-like character. The foot, too, is remarkable for its flatness, having scarcely any well defined instep. The hair, which is unkempt, and uncombed, varies considerably in length in different individuals, reaching, in some instances, to below the shoulder, but in others being considerably shorter; it may be either nearly straight or waved, but is never of the woolly or frizzly type characteristic of Negroes. Still it must be remembered that this feature is not absolutely decisive of non-relationship with Negroes, as it occurs in the Australians. And the broad "squab" noses, and large pouting lips of the Veddas show, as in our illustrations, a tendency towards the Negro type. Very characteristic of the men is the development of the beard into a stubbly chin tuft, the moustache being also short and bristly.

Armed with bows and arrows and adzes, the Veddas wander in their native forests in a state of almost or complete nudity. They are rapidly diminishing in numbers, and before long are only too likely to disappear for ever. For their customs, the reader must refer to the exhaustive work by Drs. P. and F. Sarasin, to whom I am indebted for the photographs of these extremely primitive and interesting people.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

Collections of material kept in damp places, or in a moist atmosphere, are very liable to mould, and under such conditions it is difficult to avoid this evil. Carbolic acid is recommended, but Mr. Ashmead, who has kept a large collection in the moist climate of Florida, has found the use of napthaline much more satisfactory. Mr. H. H. Smith, who has had more extensive experience in the tropics, prefers the carbolic acid. Mouldy specimens may be cleaned by washing with carbolic acid applied with a fine camel's hair brush.

Asphalt, dissolved in spirits of turpentine, is one of the best mediums for sealing cells, and, provided that no traces of the mounting medium are left on the edges of the cells before applying the solution, the cement will keep unchanged for years.

The propagation and growth of diatoms are influenced to a marked extent by meteorological conditions. They increase most rapidly during those seasons of the year when the water is in circulation throughout the vertical currents. The vertical currents keep the diatoms near the surface, where the light stimulates their growth, and where there is an abundance of air and food.

The forms of microscopic crystals may be accurately reproduced on glass by etching with fluoric acid. Interesting and beautiful effects may be obtained by crystallizing various salts in a thin layer on a glass slip which has been well warmed to prevent the crystals from dissolving, and then exposing the glass to the action of the vapour of fluoric acid for three to five minutes.

Many Aphides and Coccids are covered with a waxy secretion which interferes very materially with their easy examination. To remove this waxy secretion place the insect on a piece of platinum foil and pass it once over the flame of the alcohol lamp. The wax melts at a surprisingly low temperature, and leaves the insect perfectly clean for study. This method is particularly useful in the removal of the waxy cocoon of the pupæ of male *Coccidæ*, and is quicker and more thorough than the use of any of the chemical wax solvents which have been suggested.

Oil immersion objectives require much care in use. A small quantity only of the fluid should be employed, and then wiped off as soon as possible when finished with. The removal of the prepared cedar oil, which is generally used, should be effected with blotting paper, and the lens cleaned by first breathing on it and afterwards wiping lightly with a piece of clean, soft linen. To keep the immersion fluid unchanged it ought not to be exposed to the air for any length of time, as free access of air results in thickening and consequent alteration of the refractive index.

A kind of combination telescope and microscope has been worked out by a French microscopist for studying live insects and their habits. The new apparatus is called the "telemicroscope," and is really a small telescope having an objective formed of two achromatic lenses, which can be moved nearer together or separated by sliding the tubes. For the purpose intended, the magnifying power necessary is only 10 to 15 diameters. Besides serving for watching insects moving on the ground, the instrument, it is stated, is admirably adapted for use as a field glass.

Microscopists, both at home and abroad, will hail with satisfaction the resolutions that have recently been adopted by the Council of the Royal Microscopical Society to standardize the various parts of the microscope and its accessories. A beginning has already been made, for the details of which we are indebted to the courtesy of the Council. The standards adopted in 1882 have been withdrawn, and the size for the inside diameter of the sub-stage fitting has been fixed at 1·527 inches (38·786 mm.). The gauges for standardizing eye-pieces will, in future, be the internal diameter of the draw-tubes; the tightness of the fit being left to the discretion of the manufacturers. Four sizes of the internal diameters of the draw-tubes have been fixed as follows:—No. 1, 0·917 inch (23·300 mm.). This is the Continental gauge. No. 2, 1·04 inches (26·416 mm.), is the mean of the sizes used by the English trade for students and small microscopes. No. 3, 1·27 inches (32·258 mm.), is the mean of the sizes used for medium-sized binoculars and other microscopes of a similar class. No. 4, 1·41 inches (35·814 mm.), is the maximum size for long-tube binoculars. The sub-stage gauge is that which has been used by the English trade for many years past, the variation among different makers being not more than a few thousandths of an inch. We hope to be able shortly to give the standard gauges of the eye-piece cap and of other apparatus. The plugs and ring gauges of all of the above may be inspected by the public at the Society's rooms.

With all the diversity of interesting lines of research that are offered to the student of botany to-day, there is none more inviting to a student, or better adapted to bring into activity all the resources of his judgment, than the systematic study of the species of some limited group, provided this is properly combined with a study of the morphology, development, and ecologic relations of such a related series. The Fungi and Mycetozoa offer themselves, in a special degree, as a field for thorough and original systematic study, and students of these groups will therefore be glad to hear that Professor Lucian Underwood, of Columbia University, has just issued, in book form, an admirable exposition bearing on the moulds, mildews and mushrooms.

A simple and effective method for removing air bubbles from microscopic mounts is suggested by P. S. Proctor in the *Pharmaceutical Journal*. A small syringe, having a glass barrel, vulcanite mounts, and leather packing to the piston, is the only apparatus required. Select one that is as nearly as possible air tight, unscrew the top and remove the piston. Close the nozzle with a small piece of beeswax, half fill the barrel with distilled water, and into this drop the section or tissues to be treated. Replace the piston and screw on the top. The syringe being inverted and the plug of wax removed, the air is driven out of the barrel by raising the piston till the water begins to flow out of the nozzle, after which close the aperture with the finger and lower the piston. A partial vacuum is thus formed, and the air rapidly escapes from the cells of the tissue, collecting in the point of the syringe. By removing the finger and raising the piston the liberated air is forced out; this may be repeated several times as long as air is being expelled from the material. The same mode of operating is applicable to objects that are to be mounted in Canada balsam if oil of turpentine be used instead of water, and if the objects to be mounted are quite dry before immersion in the turpentine.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* Knowledge.]

NOTES ON COMETS AND METEORS.

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

New Comet.—The announcement has just been made (*Ast. Nach.* 3618) that Giacobini at Nice discovered a new comet on January 31st in R.A. $4^h\ 44^m\ 26^s$, Dec. 9° 55′ south. The position of the object was therefore between the stars η and ζ Eridani. The comet is moving slowly to the north-west.

During the last few months the firmament has apparently been free of comets visible in small telescopes. We have now, however, approached a season when clearer skies and more genial weather are likely to encourage the search for these bodies.

Periodical Comets.—These form a singularly interesting class, in which we have witnessed a rapid increase of numbers in recent years. The comets of short period, belonging to the Jovian group, revolving in times varying from 3·3 to about 9 years, now include about thirty members, though only half of these have received satisfactory verification by having been detected at two or more returns to perihelion. The following is a list of the approximate dates of expected returns of these bodies during the few ensuing years:—

Comet	Last observed Perihelion Passage.	Period in Years	Next Return.
De Vico-Swift	1894, Oct. 12th	5·855	1900, Aug.
Barnard (1884)	1895, June 3rd	5·398	1900, Sep.
Brorsen	1879, Mar. 30th	5·456	1901, Jan.
Denning (1894)	1894, Feb. 9th	7·477	1901, Aug.
Encke	1898, May 26th	3·303	1901, Sep.
Brooks (1886)	1886, June 6th	5·595	1902, Jan.
Swift (1895)	1895, Aug. 20th	7·220	1902, Nov.
Tempel-Swift	1897, June 4th	5·534	1902, Dec.
Perrine (1896)	1896, Nov. 24th	6·441	1903, Apl.-May
Spitaler (1890)	1890, Oct. 26th	6·378	1903, July
Faye	1896, Mar. 19th	7·566	1903, Oct.
Brooks (1889)	1896, Nov. 4th	7·073	1903, Nov.-Dec.
Pons-Winnecke	1898, Mar. 20th	5·818	1904, Jan.
D'Arrest	1897, May 21st	6·691	1904, Jan.-Feb.
Encke	1898, May 26th	3·303	1904, Sep.
Tempel (1873)	1899, June 18th	5·211	1904, Oct.

The January Meteors.—Prof. Herschel, whose important observation of the Quadrantids on January 2nd has been already referred to (Knowledge, February, 1900), has thoroughly reduced his results, and finds that several showers were actively and distinctly visible on the night mentioned. The special shower of Quadrantids formed about one-third of the total number (80) of meteors registered. The various radiants determined were:—

Shower.	Meteors.	Radiant Points.
Quadrantids	29	229° + 52°
ρ Boötids	8	286° + 34°
γ Ursæ Minorids	6	242° + 75°
ξ Coronids	8	243° + 29°
β Herculids	6	257° + 44°
ζ Draconids	7	260° + 65°

The chief display of the epoch in Quadrans is generally of very short duration, but it seems to have been unusually prolonged and conspicuous this year. The meteors were, however, most abundant on the morning of January 3rd. An observer at Chalfont, in Buckinghamshire, says that between 6h. and 6h. 30m. a.m. on the date given there were several fine shooting stars which "had tails and burst like rockets." On the morning of January 4th there were also many meteors. Mr. Robert Service, of Dumfries, reports that he started for a drive at 6 a.m., and between that hour and daylight he counted more than thirty very fine meteors, hardly one being under 1st magnitude. The prevailing colour was yellow. One brilliant meteor descended through Leo and, after bursting, left a streak which remained visible for quite a minute. Something of the display was also seen in the evening of January 2nd by Mr. J. H. Bridger, at Farnborough, and Mr. T. H. Astbury, at Wallingford, and two Quadrantids appearing at 6h. 20m. and 6h. 41m. were observed at both stations.

Of fifteen meteors mapped by Prof. Herschel on the nights of January 24th, 25th and 27th, several pretty bright, slow ones indicated a radiant in the extreme south-west region of Camelopardalus at about 43° + 63°. One of the meteors which appeared on January 25th, 11h. 10m., was fortunately also recorded by Mr. J. H. Bridger, at Farnborough, and a comparison of the two observations leads to the following results:—

Height at beginning, sixty-five miles, over a point two miles south-east of Atherstone, Warwick.

Height at ending, forty-four miles, five miles north of Rugby.

Length of observed path, twenty-six miles.

Velocity, thirteen miles per second.

Earth point, four miles north-west of Olney, Bucks.

Radiant point, 45° + 62°.

The shower is apparently the same as G.C. XLVII., with a mean position at 50°·4 + 62°·9.

Another meteor was observed by Prof. Herschel, at Slough, and Mr. A. King, at Leicester, on January 27th, at 11h. 10m. It had a radiant at 98° + 10°, and fell from a height of fifty-seven to forty five miles.

Showers of Leonids and Andromedes.—It is a remarkable fact that after the present year the two great November displays will be due on almost the same day of the year though there is a considerable difference of period, the Leonids arriving on November 15th, and the Bielan meteors on November 17th. And another curious circumstance in connection with these cometary showers is that five periods (66 years) of the latter accurately represent one period (333 years) of the former. The Leonids complete three revolutions and the Bielids fifteen revolutions in a century. Brilliant displays may possibly come as follows:—

1900. Leonids.	1925. Bielids.
1901. Leonids.	1932. Bielids.
1905. Bielids.	1933. Leonids.
1912. Bielids.	1934. Leonids.
1918. Bielids.	1935. Leonids.

THE FACE OF THE SKY FOR MARCH.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 6.18 and sets at 5.38; on the 31st he rises at 5.40 and sets at 6.29. The sun enters Aries, and Spring commences on the 21st at 2 A.M.

Observers who are favoured with clear western skies may expect to see the Zodiacal Light in the early evening.

The Moon.—The moon will be new at 11.25 A.M. on the 1st, will enter first quarter at 5.31 A.M. on the 8th will be full at 8.12 A.M. on the 16th, will enter last quarter at 5.37 A.M. on the 24th, and will be again new at 8.31 P.M. on the 30th. The following are the most interesting occultations:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Mar. 5	40 Arietis	6·1	6.22 P.M.	127	91	7. 7 P.M.	208	171	1 8
,, 8	Neptune		6.13 P.M.	161	107	7.34 P.M.	268	210	7 8
,, 10	ι Geminorum	5·2	1.43 A.M.	98	57	2.40 A.M.	290	260	9 17
,, 11	D.M. + 16° 1679	6·5	7.36 P.M.	48	68	8.14 P.M.	353	1	10 9
,, 24	Saturn		8.55 A.M.	77	56	9.46 A.M.	255	225	22 22

The Planets.—Mercury is well placed as an evening star during the early part of the month, reaching his greatest elongation of 18° 16 minutes east on the 8th at 11 A.M., when he sets an hour and forty-nine minutes after the sun; at 6.45 P.M. he will be about 7 degrees above the horizon and 3 degrees south of west. The apparent diameter of the planet on the 1st is 6″; on the 8th 7″.2; and on the 12th, 8″.2. One may expect to observe the planet to advantage during the first twelve days of the month; Venus will be about 20 degrees east of Mercury.

Venus will be a very conspicuous object in the western sky throughout the month in the early evening. At the middle of the month she sets at 9.54 P.M., nearly four hours after the sun, seven-tenths of the disc being then illuminated. At the beginning of the month she is in the western part of Pisces, but passes into Aries about the 11th and into Taurus about the 30th During the month the apparent diameter increases from 14″.8 to 18″.0.

Mars does not rise until about a quarter of an hour before sunrise, and cannot therefore be observed

Jupiter continues as a morning star, rising about 1.54 A.M. on the 1st and about midnight on the 31st His path is a short direct one in Ophiuchus until the 27th, when he is stationary. At the middle of the month the apparent diameter of the planet is 36″.2

Saturn remains a morning star rising about 2.55 A.M. on the 15th. During the month he describes a short direct path in the western part of Sagittarius.

Uranus is also a morning star, rising a little after 1 A.M. at the middle of the month. He is nearly midway between Antares and Eta Ophiuchi. He is in quadrature on the 3rd and stationary on the 17th At the end of the month the planet will be about 1° south of Jupiter and 1½° west

Neptune may still be picked up in the early evening by diligent observers; at the middle of the month he sets about 10 P.M. He is stationary on the 5th and in quadrature on the 15th At the middle of the month he is 1° north of Zeta Tauri and 3 minutes (45′) following that star.

The Stars. About the middle of the month, at 9 P.M., Aries will be nearly setting a little north of west, Taurus will be nearly due west, Orion in the south-west, Capella high up in the west, Sirius low down about 30° south of west, Procyon and Gemini higher and a little nearer the meridian, Cancer on the meridian, Leo pretty high up in the south-east, Arcturus to the east Hercules and Vega low down in the north-east.

Minima of Algol will occur on the 8th at 9.31 P.M., on the 28th at 11.12 P.M., and on the 31st at 8 P.M.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of February Problems.

(J. G. Campbell.)

No. 1.

Key-move. 1. B to Ktsq.

If 1 . . . P × Kt,	2. Q to QR7, etc.
1 . . . K × Kt,	2. Q × P, etc.
1 . . . K to K2,	2. Q × Pch.
1 . . . P to B4,	2. Q × P.

[It is noticeable that the White QB is used only to make the key-move. This would be considered an offence against the law of economy in a modern problem.]

No. 2

Key-move—1. Q to Kt6.

If 1 . . . P × Q,	2. K to B2, etc.
1 . . . P to B3,	2. Kt to Kt7ch, etc.
1 . . . Kt to K3,	2. R to B3, etc.

Other variations lead to short mat

Correct Solutions of both problems received from J. Baddeley, Alpha, Capt. Forde, W. Nash, K. W., all of whom speak of the two problems in terms of admiration

Of No. 1 only, from E. Servante, H. S. Brandreth, H. Le Jeune, W. J. Allen.

H. S. Brandreth. Your main variation in No. 2 being incorrect you are, perhaps unjustly, not credited with its correct solution, although you have given the correct key. After 1. Q to Kt6, P×Q ; 2. B×KtP, Black replies 2. . . . P to B6.

W. J. Allen.—You will see that you are right in your conjecture as to the difficulty of the second move in No. 2. It is, in fact, as you suggest, harder to find than the key, which is rather the sort of move that a modern solver would be likely to try first, on the chance of its being correct.

E. Servante, H. Le Jeune, W. de P. Crousaz.—1. Q to K2 will not solve No. 2. E.g. 1. . . . Kt to K5, threatening a check; the only defence against the threatened 2. Q to QKt2 and 2. Kt to Kt7ch. In the latter case the Knight is able to interpose at QB4, after 2. . . . K×Kt, 3. B to Kt6ch. It is a very near and beautiful "try."

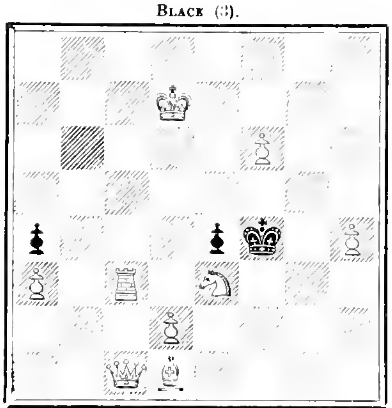
W. Nash.—Both problems in half-an-hour from the diagram would seem to show that the "rust" is very easily removed.

Capt. Forde.—Your account of previous experiences with No. 1 is very interesting. Your friend's advice to "try the least likely move" was evidently well judged.

PROBLEM.

By J. K. Macmeikan (Repton).

Black (3).



White (9).

White mates in three moves.

Mr. W. A. Shinkman, of Grand Rapids, U.S.A., probably the greatest composer of long sui-mate problems in the world, has sent the following fine specimen of his work. It is useless to give it a diagram as self-made problems are caviare to the Knowledge band of solvers. Perhaps, however, they may be induced to examine the solution appended, and see for themselves the beautiful possibilities of this class of problem. The position is:—

White—K at KR6, Q at QB8, R at QR2, Kt at Q5, P at KR7.

Black—K at Ksq, B at Qsq. White compels Black to mate in 13 moves.

Mr. Shinkman sent no solution with his "puzzle," but the following is no doubt the composer's beautiful intention:—

White.	Black.
1. P to R8, becomes Kt.	1. K moves.
2. R to KB2ch	2. K to K or Ktsq
3. Kt to KB7	3. K to Bsq
4. K to R7	4. K moves
5. K to R8.	5. K moves
6. Kt to KKt5 dis. ch	6. K moves
7. R to KKt2 !	7. K moves
8. Kt to QB7	8. K to K2
9. Q to K6ch	9. K to Bsq
10. Q to Q6ch	10. B to K2
11. Kt to R7ch	11. K to B2
12. Q to KB6ch	12. B×Qch
13. R to Kt7ch.	13. B×R mate.

The Chess Editor confesses without shame that he did not solve this from the diagram, but by a process of "looking backward" from a finish which should be worthy of Mr. Shinkman. After it had become evident that a new Knight should be manœuvred to KR7, the great difficulty was in the play of the Rook. The second move especially was quite unexpected, leading, as it does, to the extremely subtle seventh move, but the most wonderful feature of the problem is the absence of any alternative solution, if this is indeed the case.

Social Chess. By James Mason. (Horace Cox.)

Mr. Mason's latest work on Chess is a neatly bound little volume of 170 pages. It consists for the most part of a collection of 131 very short and brilliant games, each of them annotated and illustrated by a diagram, so that its progress can generally be followed without the aid of a chess-board. The names of the winners fairly represent the present century, ranging as they do from Napoleon I to E. Lasker. The names of the losers are considerately withheld. Photographic descriptions of "Social Chess-men" ancient and modern, and an interesting and very amusing history of the game form the remainder of the work. Mr. Mason's interpolated notes to the game quoted from an ancient writer are in the happiest style of both writers. There is an index of openings as well as of winners of games. The price is 2s. 6d. net.

CHESS INTELLIGENCE.

The Anglo-American Cable Match takes place on March 23rd and 24th, the British team playing in the International Hall of the Monico Restaurant, Piccadilly Circus. The two preceding days are to be devoted to the cable match between a combined team of Oxford and Cambridge Universities and a team representing the American Universities.

In the South-Eastern division of the S.C.C.U. Surrey have defeated Sussex and lost to Hampshire. Should Hampshire succeed in defeating Sussex they will tie with Surrey for the leadership of that section.

The late Professor Ruskin took a great interest in Chess, more particularly in very short and lively games, such as those of Mr. Bird. He was the originator of the expression "Social Chess," the title of Mr. Mason's book reviewed above. Professor Ruskin was a Vice-President of the British Chess Association, and the annual donor of the "Ruskin" Prize, consisting of a collection of his works.

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THE KARKINOKOSM, OR WORLD OF CRUSTACEA.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

LITTLE WONDERS AND QUEER BLUNDERS.

Linnæus was no longer in the land of the living. Lamarck had attained to middle life. Latreille was almost a young man. Cuvier was in his boyhood. Savigny and Sabine, if still babies, were at any rate already born, before the least inkling had reached the scientific world of that remarkable group of Crustacea to which the reader's attention is now invited. When the inkling came at last, it came, not as might have been expected, from Sweden or Germany or France, but from Russia. For though it may be, and has been suggested that Germany had the start by a year, the Teutonic oracle, issued by the celebrated Johann Christian Fabricius, is so obscure that nobody to this day can tell for certain what was intended by it. But the German twilight or the Russian dawn was followed in nearly forty years only by one faint quivering ray, which issued from our own Devonshire. Then a clearer light shone out of America, again with no responsive gleam during nearly a quarter of a century except a fitful shimmer from France. To this day you might search through a hundred intellectual salons, and examine the students of innumerable schools and colleges, without finding any appreciable percentage of persons who could give a reasonable account of the Cumacea.

Nevertheless it was not in inaccessible Russian but in Latin that Ivan Lepekhin described his species in 1780; in 1818 the American, Say, wrote of Diastylis arenarius in the English tongue; and during the last fifty or sixty years a large number of kindred forms have been discussed in various European languages. In the productive effort of this latter period Great Britain and Ireland can claim to have worked early and worked well, though they cannot pretend to compete with Dano-Norwegian science, led by such captains as Henrik Kroyer and Georg Ossian Sars.

Fig. 1.—*Nannastacus suhmi* Sars. Philippine Islands. From Sars.

After this historic preamble, not to raise false hopes, it is right to explain that these Cumacea have less of Æsop's bull-frog about them than any other order of the Malacostraca. Some of them, like certain of the crabs and family members of all the other orders, dwindle down to absurdly tiny proportions; but none of them ever swell themselves out to that menacing magnitude which many groups occasionally display. In a competition of length, they cannot with their champion species stretch to an inch and a half. Into a competition of breadth they have no temptation to enter. They are essentially of a spare habit. Though, like the lobster and the shrimp, they are conspicuously long-tailed (macrurous) crustaceans, in that very respect they differ most strikingly from the Macrura proper. The tail is not a muscular meat-supplying appendage, but slender, and adapted, like the tail of a scorpion, for sudden and variously divergent wrigglings and contortions. Insignificant in size, however, as they are, their enormous numbers in the North Sea potently help to fatten the shoals of herrings. This is one of the reasons for thinking that the species which Fabricius in 1779 called Gammarus esca, the Food Gammarus, was a Cumacean. The name Gammarus is now re-

-transferred to the Amphipoda, as no doubt it already was in the intention of Fabricius himself. Lepekhin in the following year called a Cumacean species Oniscus scorpioides, recognizing by the specific name the likeness to a scorpion, but using a generic name now restricted to some of the terrestrial Isopoda, known as woodlice, and bearing little resemblance to the tribe under discussion, which, but for the "relict" fauna of the Caspian, might be called exclusively marine.

The segmentation of the body and the number, succession, and character of its appendages prove the Cumacea to be a true Malacostracan order. The carapace overarches the appendages as far as the third maxillipeds, usually leaving exposed five pairs of trunk-legs, so that in this respect the Cumacea are intermediate between the higher forms (Brachyura and Macrura), in which all these limbs are as a rule covered by the carapace, and the lower (Isopoda and Amphipoda), in which not five but seven pairs of limbs are left exposed. The integument is almost always firmly crustaceous, which excites surprise, because generally such obduracy of covering is met with not in puny forms but in those of considerable size, and not always in them. On the other hand, no surprise bubbles up at the observation that these creatures have no head, that is, no head separated from the thorax, because the astonishing thing would be to meet with a crab or a cumacean or a crustacean of any kind possessing a well-turned neck, except as an anomaly or an abnormality. All the same, our first English observer, Colonel Montagu, good naturalist as he was, let himself be deceived into thinking that in his specimen "the head or fore part was wanting." He had some excuse, since this novel object was only a quarter of an inch long, nor could he find in it either eyes or antennæ. He named it Cancer scor-

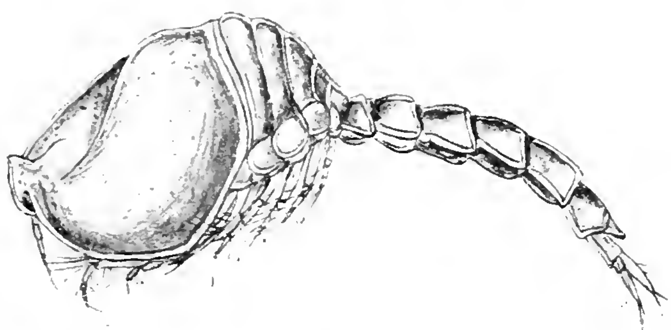


FIG. 2.—*Pseudocuma campylaspoides* Sars. Caspian Sea. From Sars.

pioides, thus independently in a second species recognizing the likeness to a scorpion, while absurdly placing it in the genus Cancer as if it were a little crab, hoping perhaps with a mop to stem the tide of progress which has been persistently comminuting the original genus Cancer, an amorphous lump, into scores and hundreds of more or less shapely genera.

Montagu could find no eyes in his small specimen. The explanation of this may be that the small median eye with its eight lenses had been accidentally obscured. In the Cumacea, as in other orders of crustaceans, there are species which see and there are sightless species. It will be remembered also that the Malacostraca are divided into two great groups, the Stalk-eyed and the Sessile-eyed. The strange thing is that for a great many years the scientific world could not come to an agreement on the knotty point, whether the Cumacea belonged to the former group or to the latter. If they had no eyes at all, well and good, there was no need to argue about the stalks. But successive writers, Lepekhin, Milne-Edwards, Goodsir, affirmed that they had eyes, and Say, though he could not see them, took their presence for granted. Kroyer began by examining species that were really blind. About the same time Goodsir investigated species that really had eyes. Then Erichson, in 1844, expressed what he supposed to be Goodsir's opinion by saying, "the stalked eyes are very small and concealed under the carapace (which no doubt was the cause of Kroyer's

FIG. 3.—*Cumella limicola* Sars. Eyes and front of Carapace. From Sars.

not finding them)." Kroyer, for his part, in 1846, believed the eyes to be what one might call an ocular delusion; and so he says, "Goodsir thought that there must be eyes to be found in the creature and he therefore found them." Goodsir unhappily perished in an Arctic expedition, and was never able to defend or explain his clearly printed statement that "the eyes in this tribe are exceedingly small, they are pedunculated, but sessile." It is amusing to notice how this remark has been treated by subsequent writers. Erichson and De Kay accept the epithet "pedunculated" and ignore the qualifying words "but sessile," which seem to come from the lips of Mr. Facing-both-ways. Kroyer and Bell cannot away with a description which is, as they rightly say, a contradiction in terms. But, look you, in spite of this, in 1870, Anton Dohrn found or fancied in a larval form a little downward bent eyestalk, which at a later stage was completely enclosed by the carapace. This he offers as an olive branch, a symbol of peace, between the disputants, saying, "Curiously both sides are right,—as already before me Henry Goodsir expressed it, 'the eyes are pedunculated, but sessile.'" He seems to forget that Goodsir was concerned not with immature but with full-grown forms. With a boldness greater than Dohrn's, Eugene Hesse, in 1868, described an adult cumacean as having eyes which "are not precisely sessile, nor yet completely pedunculated; they hold the mean between the one thing and the other." What could be more accommodating, what more pacificatory? And, after all, the whole controversy hangs on a misprint, as suggested by Fritz Muller in 1865. Nothing, I think, in this uncertain world can be more absolutely certain than that Goodsir's intention was to say that the eyes are "not pedunculated, but sessile," in accordance with the obvious fact. Only, the printer or the penman left out the inconsiderable word "not." Goodsir goes on to say of the eyes that "they are placed very close together," and that "they are covered by the shell," arrangements not absolutely incompatible with the possession of stalks, though alien to it, but the plates which accompany his description exhibit sessile-eyed species with the most uncompromising plainness. No man in his senses would describe a new scientific object as "long, but short," or "black, but white," without some explanatory signal that he was indulging in a whimsical paradox.

Not th[illegible]s alone excited controversy. A question was r[illegible] whether these peculiar little animals were anything more than larval forms, and, what is almost more peculiar than the animals themselves, is that the justly illustrious Henri Milne-Edwards, down at least to 1861, was still on the wrong side of the argument. Though he had himself with some care introduced a Cumacean to European science in 1828, though his attention was repeatedly called to the subject, though he had the writings of Goodsir, Kroyer, and Spence Bate, conclusively showing the right view, he remained obdurate. With him was L. Agassiz, with him, apparently, though in less demonstrative fashion, were Dana and Huxley. They all agreed in supposing the Cumacea to be immature forms, and they were all wrong. In fact the Cumacean at birth already resembles its mother, except that the last pair of trunk-legs is as yet undeveloped. A natural warning against the larval hypothesis lay also in the strong sexual dimorphism of these animals. The males are distinguished from the females by the great length to which their second antennæ are developed, by having exopods or swimming-branches attached to all the first four pairs of trunk-legs, and having pleopods on the first five, or some of the first five, segments of the pleon. Not often are all these distinctions available together but always one or more of them. The superior swimming power of the male makes him often at night time a victim to the tow-net sweeping the surface of the sea, while his less agile mate is lying in safety far below.

Some of the species show an almost balloon-like expansion of the front part. But, be it corpulent or slim, its contents are much the same, and worthy of investigation. For this, however, they present a task of some delicacy, being soft and easily damaged goods packed in and attached to a rather unyielding and brittle case. This helps to account for the strange muddle which P. J. van Beneden made in 1861, for, while examining different species, he seems to have lost two pairs of

Fig. 4.—*Cyclaspoides tenor* (Fischer). Bay of Biscay and Mediterranean. From Sars.

the appendages and not to have definitely known which two pairs he had lost. At the same time, by the general excellence of his work, he created a confidence which misled Claus into believing that in the Cumacea two pairs were really missing. That is not the fact. Everything is in order. Those who dissect with the needful skill will find in the Cumacean a heart and "liver," ovarial or seminal ducts, intestinal canal, ganglionic nerve-chain, thinly partitioned branchial chambers, eyes (or no eyes), two pairs of antennæ, mandibles, two pairs of maxillæ, three of maxillipeds, and commonly five pairs of trunk-legs. Of all these the supremely interesting objects are the first maxillipeds. These somewhat leg-like jaws have in their standard features nothing to call for special remark here. The accessories are the essentials. Every Malacostracan appendage, as the reader knows, may possess an epipod on the first and an exopod on the second joint, but these are often inconsiderable, evanescent, or wholly wanting. In these Cumacean maxillipeds they are large and of the first importance, coalesced into a powerful organ, stretching b[illegible] and as essential to the life of the C[illegible] in some respects unique in Malacostra[illegible]. The hinder part forms a great branchial [illegible] amply [illegible] by numerous leaflets on [illegible] surface. The forepart ends in a pellucid [illegible] one

Fig. 5.—One maxilliped of first pair of *Diastylis sculpta* in lateral view.

Fig. 6.—Maxillæ and first maxillipeds of *Diastylis sculpta* Sars. From Sars.

species, when the animal, alive, and lying still, is viewed in sea water, the pair of pellucid ends will be seen to shoot forward at the front, and then to be in turn withdrawn. When advanced, they form, with the frontal projection of the carapace, a closed but yielding tube through which the water of respiration is expelled. When retracted, they fold over to preclude the return of the used-up water, while the maxillæ make way for a fresh stream to bathe the branchial blade. This apparatus is not constructed precisely in the same way in all the families of the group, and, though the most singular part of the organism both in structure and mode of action, it is not the only part worthy of notice. But space is less at our command than specimens are at the command of the student. To recom[illegible] above all he should have recou[illegible] copious literature by which the subject [illegible] illustrated. Among the more recent writers, A. M. Norman, H. J. Hansen and Jules Bonn[illegible] but all the pens and pencils of [illegible] this subject have not produced enough [illegible] has been done by G. O. Sars. A [illegible] examine the sands of the shore, th[illegible] sea and its surface, are now known t[illegible] creatures in abundance, so that ther[illegible] need to wonder and blunder over solitar[illegible] though the need for strong eyes and open [illegible] and for courage, remains the same as of old.

SIR JOHN SIBBALD ON SUICIDE.

By Dr. J. G. McPherson, F.R.S.E., Mathematical Examiner in the University of St. Andrews

At a recent meeting of the Royal Society of Edinburgh, Sir John Sibbald, retired Commissioner on Lunacy, gave some very interesting results of his examination of the statistics of suicide in Scotland for many years. And the most startling, though at the same time the most comforting, was his conclusion against the opinions of all who had not carefully investigated the case, as to the increase of suicide. He found that it was not really on the increase.

He first drew attention to the fact that the statistics of Scotland showed the increased number of suicides during May, June, and July, compared with November, December, and January. This coincides with the result of statisticians in other countries. The winter decrease was not owing to the deterrent of cold water by drowning, but in the other forms of wounding, poisoning, and hanging.

In regard to the comparative influence of town and country life on the occurrence of suicide, Sir John found that suicide was not—as was generally supposed—more frequent in towns. In fact, the annual rate per million of population in the eight principal towns of Scotland was somewhat lower than the rate in mainland rural districts.

He found great—even remarkable—differences in the rates for different parts of Scotland, the counties all along the east coast having higher rates than those along the west coast. The average rate for the whole of Scotland (from 1877 to 1894) was 55 per million of population. The lowest rates were for the Highland counties lying north-west of a line drawn from the Moray Firth to the Firth of Clyde. The rate for Inverness was as low as 27; whereas in Kincardine, on the east coast, the rate was as high as 92. This showed that the Scotch statistics bore out the statement of previous writers—that suicide was far less common among the Celtic race than among the Teutons, being a more dreamy and less determined race, and that in this respect the Highlanders and other Celtic people were more like women.

Medical men are of opinion that, although the proportion of the male sex who committed suicide was large in comparison with the female sex, women had quite as strong suicidal tendencies as men, if not stronger, but they lacked the courage to put their feelings into effect. Hence, though the tendency may be as strong in the Highlander as in the Teuton or the Roman, he had not the courage of his suicidal conviction

Until Sir John gave us the result of his extensive investigation, it was held by most observers that suicide has been increasing to a great and perhaps alarming extent in recent years. The average rate for the years 1865-1869 was 40 in Scotland and 67 in England, whereas the average rate for the years 1890-1894 was up to 54 in Scotland and 86 in England—an increase of 35 and 28 per cent. respectively in thirty years. Two factors come in to account for this. The state of public feeling as to suicide has changed; the belief that an act of suicide necessarily involved disgrace has greatly diminished since suicide has been recognised to be, to a great extent, the result of mental disease; and, in consequence of this change of opinion, efforts to conceal its occurrence have correspondingly decreased. That is one reason. The second is that as suicides have increased, accidents have decreased. In the only case where suicide, by the strict police and registration machinery under statute, is now impossible to be concealed, viz., by hanging, the rate during that period is unchanged: it stands fixed at 16 per cent. in Scotland and 26 per cent. in England. That is an important fact. But turning to the suicides by the other methods—poisoning, wounding, and drowning—it is found that almost exactly as these rates have increased, the rates for accidents from the same causes have decreased. Similar results are shown from the English statistics—that the total increase in the rates of suicide by wounding, poison, and drowning is exactly counterbalanced by a total decrease in the rates of accident from the same causes. Accordingly the alleged increase of suicide is not proven.

Dr. Clouston, one of the highest authorities on mental diseases, followed this up by mentioning a very curious fact—that the average rate of suicide between the ages of fifty-five and seventy is greater than that between fifteen and fifty. He stated his decided opinion that sexual influences mainly accounted for the difference. He showed that up to fifty a man or woman is, or should be, full of life, vigorous, and healthy; consequently possessed of a strong desire for the reproduction of the race; and that while possessed of that feeling he or she had no desire to die, but rather a strong desire to live. On the other hand, in the later years the body became less vigorous, the blood less easily inflamed, and consequently sexual feeling became less strong, and the wish to live gradually passed away and the tendency to suicide became stronger.

Dr. Clouston was also of opinion that excess of alcohol led to a condition of brain which frequently led to suicide. It was not so much worry as drink that was the prevailing incentive. Alcohol, over-indulged in, produced the paralysis of the great human vital instinct of self-preservation.

Sir John Murray instanced another aspect of suicide, and related a curious spectacle of which he was a witness a good many years ago in China. A large number of youths were being examined for some Chinese degree. The examination was held along the bank of a river, each candidate having a small temporary booth fitted up for him on the bank. The opposite bank was lined with thousands of spectators; and when an unlucky candidate failed to pass, he was expected to walk into the river and end his disgrace.

It was pointed out by Dr. Clouston that German authors held that the Roman Catholic portions of their Fatherland did not show so many suicides as the Protestant part. There they had the moral and religious element coming in, which prevented men and women from committing suicide, even when they were diseased and felt suicidal. And Sir John Murray expressed his opinion on this that it would always hold good that in those countries where they had individual responsibility, as they had in all Protestant countries, for opinions and for religious beliefs, there necessarily they would have a disturbance more frequently resulting in suicide than in the Roman Catholic faith, where they had the firm idea of corporate responsibility.

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor Alfred C. Haddon, M.A., D.Sc., F.R.S.

II.—THE PASTORS OF THE STEPPES.

In my first article, in the February number of Knowledge, I briefly described the social condition of hunting folk, more particularly those of the tropical forests of

South America, as these exhibit a very simple social organisation, but I do not wish it to be understood that I consider all other human societies were necessarily evolved from similar societies to that which I described. It may have been so; on the other hand, there is to my mind no reason why pastoral or agricultural communities may not have independently arisen in some cases from a stage of simple exploitation of natural resources. This I would regard as an earlier stage than that of hunting, employing that term to indicate the quest of beasts, birds, and fishes; whereas in what may be termed "simple exploitation" the natural vegetable products of the forests and jungle form the greater portion of the sustenance of savages at this primitive grade.

I now propose to describe the social condition of perhaps the most permanent and stable of all simple societies—that of the pastors. The materials for this study have been gathered from a series of articles by M. P. Bureau, in "La Science Sociale," Vols. V. and VI., as well as from a paper by M. E. Demolins in Vol. I., and from other sources. At present I am not concerned with the manner in which the herding of cattle may have arisen, but with the life of pastoral peoples on the steppes of Asia, and of these the Kalkas may be taken as typical, as it is generally admitted that these people are very pure representatives of the Mongolian race, and have maintained the old style of life.

Environment.—The country inhabited by the Kalkas is the northern portion of the great Central Asiatic plateau. It forms an immense basin, of which the border attains an altitude of 13,000 to 16,000 feet, and in places much higher still. It extends from latitude 45° N. to 51° N., and from longitude 90° E. to 120° E. This area has an extent of about 500 miles from north to south, and 1250 miles from east to west; it is bounded on three sides by mountains, and on the south by the Ganghin Daban hills, which protect the fertile plains to the north from the inroads of the sand of the Desert of Gobi.

One can understand that in a country so clearly circumscribed its inhabitants can more easily retain their primitive character, foreign influences penetrate with difficulty, and the whole people will preserve their homogeny and similarity of customs.

The altitude determines the peculiar climate, which is inordinately cold, snow persisting on the ground during a greater part of the year. Thus we have the two characters of a steppe—(1) the production of grass; (2) the more or less complete exclusion of other vegetation. This is caused by a short season of humidity regularly intervening each year between a barren winter and a summer, the dryness of which stops the growth of all vegetation. This intermediate season suffices for the growth of grass but is insufficient for the young shoots of trees.

Le Play has pointed out that the snow persists on the plain after it has disappeared on the slopes of the same region, owing to the heat of the sun in early spring melting the superficial snow, and the water filters down into the deep layers, when it freezes in the night and forms a more compact and resistant layer. At length the time arrives when the snow has vanished, the soil, thoroughly soaked with water, is suddenly exposed to an already elevated temperature. The grass grows immediately with an extraordinary rapidity on the incomparably fertile plain.

In several days in the spring the grass grows as high as the waist, and were it not for the dryness and heat of the summer it would everywhere attain the height of a man, as it does in favourable spots; but soon its roots become dry, and the grass lies flat on the ground until the return of spring. Having noticed that the old grass smothers that which is sprouting, the Kalkas sometimes set fire to it at the advent of spring. The fertility of the soil resembles that of the famous "black earth" of Russia and the "yellow earth" of China. The fertility is increased by the abundance of water.

These conditions, so favourable to the growth of grass, are by no means advantageous for agriculture. The soil is fertile enough, but, owing to the altitude, the climate is too severe for grain to ripen.

Winter extends for three-fourths of the year, there is practically neither spring nor autumn, tropical heat succeeds without transition to arctic cold. Huc states that in the country of the Kalkas the cold is so terrible that during the greater part of the winter the mercury of the thermometer freezes. There are also extraordinary diurnal changes of temperature, and consequently great atmospheric disturbances and tremendous storms arise both in winter and summer. No wonder then that such good agriculturists as the Chinese have failed to cultivate the soil.

The seeds of trees spread over the plain before the winter season do not remain inert; sometimes they even germinate before the grass; but they rarely raise themselves to a height of above four inches. Soon swamped in the grass they are stifled, or, at least, blanched. Those that preserve some traces of life are killed by the blazing sun, which, having withered the grass, makes itself felt on the parched ground. This embryo forest perishes annually, because it cannot find in the steppe either the necessary room for growth or sufficient rainfall; but in favourable positions there are forests of pine, fir, larch, and black birch; the aspen and cedar are rarer. In any case the wood is of poor quality.

The most important animal of the steppe is the horse. Wild horses are spread over the whole region, and are so active that they escape from the arrows of the most skilful hunters. Often they move in compact troops, and when they meet tamed horses they surround them and force them to take flight. Cattle and sheep are very numerous, and Nature not only provides them with abundant fodder but has spread salt in profusion all over the country. The Kalka sheep are especially famous. The camel and dromedary are scarce; the pad of their feet is badly adapted for walking on the harsh crust of the snow. They are only used as beasts of burden.

There are a few wild asses, boars are found in the wooded western districts, and wild goats sometimes appear in immense flocks. There is other game, such as deer, antelope, hares, birds, etc. These are automatically kept in check by bears, tigers, and wolves, the latter being the worst enemy to man.

Occupation.—From the foregoing account it is evident that the population has only two methods of sustenance—hunting or herding. In the analogous prairies of North America the Red-Skins adopted the former mode of life, or perhaps it would be more correct to say that the absence of the horse compelled them to hunt bison; but in Asia the presence of the horse rendered it possible for the Mongols to tend large herds.

Mr. T. W. Atkinson describes his first visit to a

Kirghis chief, who possessed more than 2,000 horses, 6,000 sheep and goats, 1,000 oxen and cows, and 106 camels. Even these were far short of the total number of animals belonging to the patriarch chief.

Each day this patriarch had to provide for the fodder and water of nearly 10,000 beasts. The problem would be insoluble for a sedentary people, but the Kalkas find an easy solution in their mobility. The large flocks radiate from the central "aoul," directed by men on horseback. This has to be accompanied by periodic migration. The route is not taken by chance, it requires all the experience and wisdom of the patriarch. However well watered may be the country, the abundance of water is far from equalling that of the pasturage and the flocks cannot go long without the one as well as the other. It is then that the immense importance of snow is appreciated. It permits the nomads to utilise the forage of the more elevated parts and furnishes them with the wherewithal to water their beasts; further, in covering over the grass, and thus preserving it from contact with the air, it constitutes a kind of immense store-house of fodder; it is, in fact, a huge natural system of ensilage, which the horse can reach with his hoof whenever he has need. Without this protection the grass, exposed to all the inclemencies of the atmosphere, would rapidly perish, and the flocks would be deprived of all nourishment during the winter. The experience of the patriarch leads him to select the most sheltered valleys in the south for the winter and the most northerly and shaded plains for the summer.

The actual care of the flocks is neither a fatiguing nor difficult work. Most often it suffices to sit with crossed legs on a tussock in quietness and peace. The great tranquility of the steppe and the limitless horizon predispose the mind to meditation, and the inaction of the body tends to idleness. Huc says: "The appearance of the prairies of Mongolia excites neither joy nor sorrow, but rather a mixture of both, a melancholic and religious sentiment, a feeling that regards heaven rather than earth, which by degrees elevates the soul without making it entirely oblivious to matters here below."

On the other hand, very often it is necessary for the herder to throw himself on a horse and rapidly pursue a straying animal or some beast of prey. It is no small matter to guard a herd of more than 300 head of large cattle. A saddled horse is always fastened at the entrance of each sentry tent; at the least signal the horsemen, from eight to a dozen in number, rapidly take the direction of the fugitive. Then commences for our Kalkas a giddy course that may last for several days. They do not go to the encampment for news of the straying beasts, but whenever they meet a lama they dismount and prostrate themselves, and say with deep feeling, "Man of prayer, we come to ask you to draw a horoscope; your powers and knowledge are limitless, indicate to us where we should go to recover our horses"; and again they fly like the wind.

The Kalkas have also to protect their flocks from Nature herself. When the winter hurricane tears up the snow, and the plain resembles a sea in its fury, the frightened animals break loose in all directions, and the camels increase the universal tumult with their cries. "Then the intrepid herdsmen courageously fly to the succour of their flocks; one sees them bounding from one side to the other, to encourage the animals by their cries and to conduct them to the shelter of some hill." (Huc.)

The second aspect of the pastoral life explains the agility and remarkable suppleness which, in all times, have made the nomads the finest horsemen in the world. The daily necessity of pursuing animals in flight has given muscular vigour and insensibility to fatigue which is astonishing; but it has not developed a capacity for walking, this a Kalka considers as humiliating. The senses of sight, hearing and smell are wonderfully acute and trained.

The work of the men is essentially attractive, it is more of a recreation than a labour; but it is by no means so for the women. The food these nomads prefer is milk and various preparations from it. All the milking is done twice daily by the women, except that of the mares, who, being more restive, are milked by the men. At foaling time these women have yet more to do; the care of the sick animals also falls to their charge.

The work of the house is exclusively woman's sphere. There are the boiled and fermented preparations of milk, the making of butter and cheese. The women have to fetch in skin vessels the water for tea, for this is the drink the Mongols prefer. They cook and smoke the meat. They collect argols (cakes of dried dung) for fuel, which are dried in the sun; the collecting of argols in winter is especially difficult. Each family group is isolated, and consequently each group has to make nearly all that is needed. Fortunately the pastoral life furnishes in abundance the raw material of these domestic manufactures in the wool and hair of their herds and in their grease and hides. The manufactures are executed at home, and for the sole needs of the home; naturally these fall to the women. Much of this is hard work, especially the tanning of leather and the fulling of wool. The grease of animals is utilised as an illuminant and mixed with ashes to form a soap. Several plants or tea furnish dyeing materials. With the tanned skins the women make water bottles, clothes, shoes, saddles and harness. The fabrics of wool and camels' hair serve for making clothes, whilst felt gives the family spacious and warm tents which protect it from the rigours of winter.

All the labours of shifting camp—of lowering and pitching the tents—fall to the women. This is very arduous work, as the tents are large, with three felted coverings, and it is especially hard when the tents are frozen in winter. The Kalka country is not exactly a paradise for women.

Property.—There is no individual ownership of land. The soil belongs to the nation, and to enjoy its use it is necessary to belong to the nation or to formally obtain a concession. A Kalka can, however, camp where he likes provided he does not interfere with anyone else. Thus the temporary possession of land imposes the obligations of neighbourhood and a respect for the pleasure of others. Each must see that his animals do not throw into disorder the flocks of a neighbour or provoke them to flight. When there is a prairie fire every one must, on pain of death, turn out to extinguish it. Concessions are not always irrevocable, as the Chinese have experienced. One day a patriarch, renowned for his courage and wisdom, assembled the Mongols of the neighbourhood, and said: "The Kitas possess themselves of our land, they steal our cattle and vilify us; since they no longer act nor speak like brothers we must expel them." The Chinese did not obey the decree ordering their expulsion, so one day they were driven away. According to a Chinese regulation the chiefs chosen by the Emperor to be the intermediaries of his Government should be the proprietors of the entire soil; it does not appear that this theory has at present any practical consequence.

While landed property is unknown, moveable property in cattle attains a considerable development, as the animals require continual care and watching they necessarily become an object of individual property. Of all the animals the horse takes front rank; it is caressed and extolled with affection in song; money is often lavished on the harness. When a traveller asked a patriarch, the proprietor of several thousand horses, why he did not sell some every year, he replied, "Why should I sell that which gives me pleasure? I have no need for money, and if I had it I should shut it up in a box where no one would see it. But when my horses traverse the steppe, whoever sees them knows that they belong to me, and that I am rich." The theft of flocks, especially of horses, is still, more than the usurpation of pasturages, one of the causes of the interminable wars which trouble the tranquility of the steppe. The ownership of a flock is such a necessity for a Kalka that he cannot imagine a man capable of living without owning beasts. It is needless to point out what an element of stability and security the family finds in this property, which, apart from disaster or epidemics, ensures subsistence.

The Family.—The pastoral occupation has permitted the old men to preserve their authority; they alone have the necessary experience and wisdom for it, and it is by no means an easy matter to command four or five hundred persons. As their authority is uncontested, so it is accompanied by absolute respect.

The pastoral art scarcely tends towards the development of riches and luxury, but does tend to maintain between men an almost complete equality, and the isolation of families emphasises the ties of blood.

As husband, the patriarch receives by right the respect and most attentive care of his wife, and as the Kalka has not arrived at the idea of the relations of master and servant he marries as many wives as he can afford in order to have plenty of service, but as the husband has to pay to the parents of the bride a large price in beasts, polygamy is a luxury that is accessible only to the rich and powerful.

The children have a profound veneration for the father, and have to go on their knees when they address him and receive orders from him. Filial piety is the first of the duties, and the "Holy Doctrine" teaches that it is better to honour father and mother than to serve even the spirits of heaven and earth. When the time has come to marry, the wish of the patriarch is sufficient to constrain a son even against his will. It is rare that a young man can consult his taste the first time that he marries. As to the young girls, they are not even allowed to have a wish.

As the depository of the traditions of the ancestors, the patriarch faithfully transmits them to those around him, and all listen with respect. He is the supreme judge of all the members of the aoul, and he has full authority to punish offenders. On sacred days he offers milk and mutton to the image of Buddha, which is placed at the back of the tent.

The first wife enjoys wide liberty and great power, the whole responsibility of the household falls upon her and also the education of the young children. It is therefore important that she should be capable, and that her character should be such that she can get on well with the other women. Such are doubtless the reasons why the patriarch choo[illegible] first wives the comfort and well being of the [illegible]munity is of more importance than the predilection [illegible].

Government. There is no [illegible] external to the family. The patriarch combines [illegible] functions of father, teacher, magistrate, priest, and [illegible]. The sole grouping above the family is the tribe, but it is more an union of several families of common origin than a fixed territorial grouping. The tribe is mobile like the family. The central government has not a more real existence. It is at most a kind of nominal and vague protectorate that is exercised, partly by Russia and in part by China. It manifests itself by the claim for a tribute, which is rarely collected owing to the difficulty at getting at these singular tributaries.

Peace reigns among the pastors. These men, so dreaded in the numerous raids they have made in other countries, are quiet, sociable, and hospitable in the steppe, where they have no foreign competition to fear.

The Expansion of the Herders. The pastors of the prairies are apt to swarm, but they are not qualified to organise invasion or to remain masters of the conquered country; but this aspect of their life will be dealt with on a future occasion.

THE PHOTOGRAPHY OF CLOUDS.

By Eugène Antoniadi, F.R.A.S.

A few days after the publication of the paper on "Clouds" in the September, 1899, issue of Knowledge, the writer received a number of letters from English meteorologists and photographers, asking him to give some further details on the method used in photographing cloud forms at Juvisy. Hence the excuse for the present complementary notes.

The first point to be attended to in cloud photography is to have the camera and plates always ready, so as to be in a position to immediately photograph any evanescent atmospherical phenomenon. Trivial as the statement appears, it is of paramount importance. In fact, without this precaution the negatives of rainbows, solar halos, lunar coronæ, etc., would probably never have been secured at Juvisy. As a rule, the persistence of fine cloud effects, or of the optical phenomena of the atmosphere are of very short duration, and the loss of time involved in fetching plates or engaging in other preparatory work at the last moment, is often a source of disappointment; for instance, to see a bright rainbow fade off and vanish when "everything is ready," produces a tantalizing effect too galling to be endured more than once when economy of time will serve as a preventive medicine.

It has been found that the number of days yielding interesting forms of clouds is but a limited one. Long weeks succeed each other without our recording a single typical cloud. Occasionally, however, we may observe the richest forms undergoing rapid and singularly beautiful transitions.

With regard to the choice of an apparatus, it may be said that all cameras, large or small, and mounted or unmounted, can be employed in cloud photography. A large angle lens will be generally found more serviceable, enabling, as it does, the student to photograph clouds of large dimensions, a considerable arc of the rainbow, or ordinary halos of 22° radius as nearly complete circles. But it is, of course, preferable to have a variety of object glasses, capable of being indifferently and rapidly adapted to the camera according to the nature of the cloud to be photographed.

The glass should, of course, be provided with a shutter adapted to varying speeds. At Juvisy, an ordinary Thornton-Pickard shutter, with a maximum speed of 1/80 second, has been found very useful. Hand cameras supplied with speed regulators, act in an equally satisfactory manner.

If a cell containing a yellow solution be used as a screen destined to quench or attenuate the blue of the sky, the distance separating the glasses need not be smaller than [illegible]-inch, or greater than ¼-inch. Bichromate of potash, mixed with a few drops of chlorhydric acid, yields beautiful yellows. At the Bureau Central

Fig. 1.—Fibred Cirrus, 1899, August, 1d. 2h. 40m., local time.

Meteorologique, M. Angot uses cells ¼-inch thick and containing more or less saturated solutions of bichromate, according to the varying intensity of the clouds. The most coloured mixture contains 10 per cent. of the yellow substance; another 5, and a third 2½ per cent. only. The first screen is advantageous on feeble contrasts, such as light cirri near the horizon, or in hazy skies. The 5 per cent. solution is generally the most serviceable on ordinary cirri. The last screen is chiefly used on cumuli. Should the contrast between the silvery crests of the cumuli and the dark blue sky be very marked, then the coloured screen might be dispensed with altogether.

The proper time to give to the exposure is the beginner's stumbling block. In fact, the question is of a very complex character, inasmuch as it depends on a large number of factors, such as the angle of the object glass, the diameter of the stop, the sensibility of the plates, the saturation of the screen, the luminosity of the cloud, the sun's altitude, etc. Laying down a rule for the exposure is an impossibility under such circumstances. But the reader may be interested in the data accompanying the annexed photographs.

Fig. 2.—Cirrus with Wisps, 1839, August, 1d. 2h. 35m., local time.

Plate, Fig. 1.—Cirro-cumuli transiting across the Sun; following and preceding wet weather. Photographs taken with an object glass 1·04 in. aperture and 5·12 in. focal length. No yellow screen. Stop = $\frac{f}{10}$. Exposure = [illegible] second.

Fig. 3.—Cloud Ripples, 1899, September, 25d. 2h. 23m., local time.

Plate, Fig. 2.—Gigantic thunderstorm Cumuli during hot, showery weather. Same object glass. Slight yellow screen. Stop = [illegible]. Exposure = [illegible] second.

Fig. 1 (text). Cirrus in bands, attending a barometric fall after fine weather. Same object glass. Strong yellow screen. Stop = [illegible]. Exposure = [illegible] second; lengthened on account of the yellow's absorption.

FIG. 1.—Cirro-cumulus passing before the Sun, 1899, September, 23d. 4h. 3m., Mean Local Time.

FIG. 2.—T[illegible] storm Cumu[illegible] Paris 1899 September 28[illegible] 3[illegible] 2m., L[illegible] Time.

CLOUD PHOTOGRAPHS TAKEN AT M. FLAMMARION'S OBSERVATORY, JUVISY, FRANCE.

Fig. 2.—Cirrus in wisps. Same object glass. Strong yellow screen. Stop=$\frac{1}{10}$. Exposure=1$\frac{1}{4}$ second.

Fig. 3.—Undulated Cirro-cumuli, seen during a spell of sunshine during rainy weather. Same object glass. Mean coloured screen. Stop=$\frac{1}{10}$. Exposure 1± second.

It is thus obvious that as far as exposure is concerned, continued practice will be the safest guide. The student should also bear in mind that with a long focus glass, rapidly moving clouds, such as scud flying before heavier masses during a gale, should be photographed with very short exposures only, if he seek to avoid the disagreeable effect of dimness due to the clouds' motion.

(*To be continued.*)

MME. CERASKI'S SECOND ALGOL VARIABLE.

Another remarkable variable star of the Algol class has been discovered by Mme. Ceraski, and is announced in the Astron. Nach. 151, 223. The position for 1900 is R.A. = 19h. 42m.7, Dec. = +32° 28'. From an examination of the Draper Memorial photographs of this star, it appears that while the star has its full brightness on 45 of them, on several of the early photographs it is so faint that they must have been taken when the star was near minimum. The Moscow photographs furnish the means of determining the period from an interval of four years, the Harvard photographs increase this interval to nine years. The period is 6d. 0h. 8m.8. The period differs so little from exactly 6 days that for a long time the minima cannot be observed in certain longitudes. Accordingly, while valuable observations may be obtained next autumn in Europe, or better still in Asia, minima cannot be observed in America until the following year.

Five stars of the Algol class, S Cancri, U Cephei, W Delphini, +45°3062, and the present star are especially interesting, owing to the large variation in their light, which amounts to about two magnitudes in each case. It is remarkable that two of these were found by Mme. Ceraski, and one by her distinguished husband.

Edward C. Pickering.

Harvard College Observatory,
February 12th, 1900.

ASTRONOMY WITHOUT A TELESCOPE.

By E. Walter Maunder, F.R.A.S.

III.—THE NORTHERN STARS.

The stars wear a very different aspect to the astronomer with a telescope and the astronomer without. The former, deep in his observatory dome, sees but a narrow slice of the sky through the open shutter, and the starry groupings as such have little or no significance for him. If he wishes to bring a star within the field of his instrument, he does not as a rule seek it out first on the sky, and there aim his telescope at it like a rifle by its sights. Instead he refers to his catalogue, reads therein the right ascension and declination of the object, turns his instrument until its circles are set to the readings indicated by the catalogue, and then, last of all, moves his dome round until the shutter opening is opposite the object glass. The names of the stars, the constellations in which they are found, have therefore very little significance for him. The important things for him to know are the hour, minute and second to which the one circle must be set; the degree and minute to which the other.

Not so with his brother worker. He stands out under the open heaven; no graduated circles guide his gaze to this star or that. For him, if he will know precisely to what part of the heavens he is directing his attention, it is necessary to be able to recognise the individual stars. In this work differences of brightness and colour are no small help, but by themselves would be perfectly inadequate guides to the recognition of the great majority of the stars. That by which one star can be recognised from another is in most cases its grouping with the rest. The knowledge of such grouping, a perfect and quick recognition of the figures, real or imaginary, which the stars make up amongst themselves, in a word a knowledge of the constellations, is the first essential for the direct observer. It was so from the very beginning. The first astronomers necessarily had no telescopes, and equally of necessity the first great astronomical enterprise was the dividing out of the heavens into constellations, the ascribing certain imaginary figures to particular groups of stars, and the bestowal of names upon individual stars themselves

The same necessity makes itself felt in every branch of science. Before any progress can be made the objects recognised in that science must be named. Until they are named they are undistinguished and undistinguishable. So far as we are concerned they remain without properties, one might almost say without existence; once named, a knowledge of their properties and peculiarities begins and a whole new field of research is opened out.

And even without this further knowledge, how great an interest is given to any object by the fact that we know its name. Take some town children out into the country, and set them to gather wild flowers, how instantly they ask their names, and how much their beauty is increased in their sight when those names are taught them. And so to-day we are continually hearing the complaint of Carlyle repeated:

> "Why did not somebody teach me the constellations, and make me at home in the starry heavens, which are always overhead and which I don't half know to this day?"

So the work of learning the stars, though it may involve some self-denial, and brings no reward in the shape of "magnificent spectacles," has a charm of its own. The silent watchers from heaven soon become each one a familiar friend, and to any imaginative mind the sense that he is treading the same path as that traversed by the first students of Nature will have a strange charm. With the "Poet of the Breakfast Table" he will feel himself linked to the great minds of the deep unmeasured past.

> "I am as old as Egypt to myself;
> "Brother to them that squared the Pyramids,
> "By the same stars I watch."

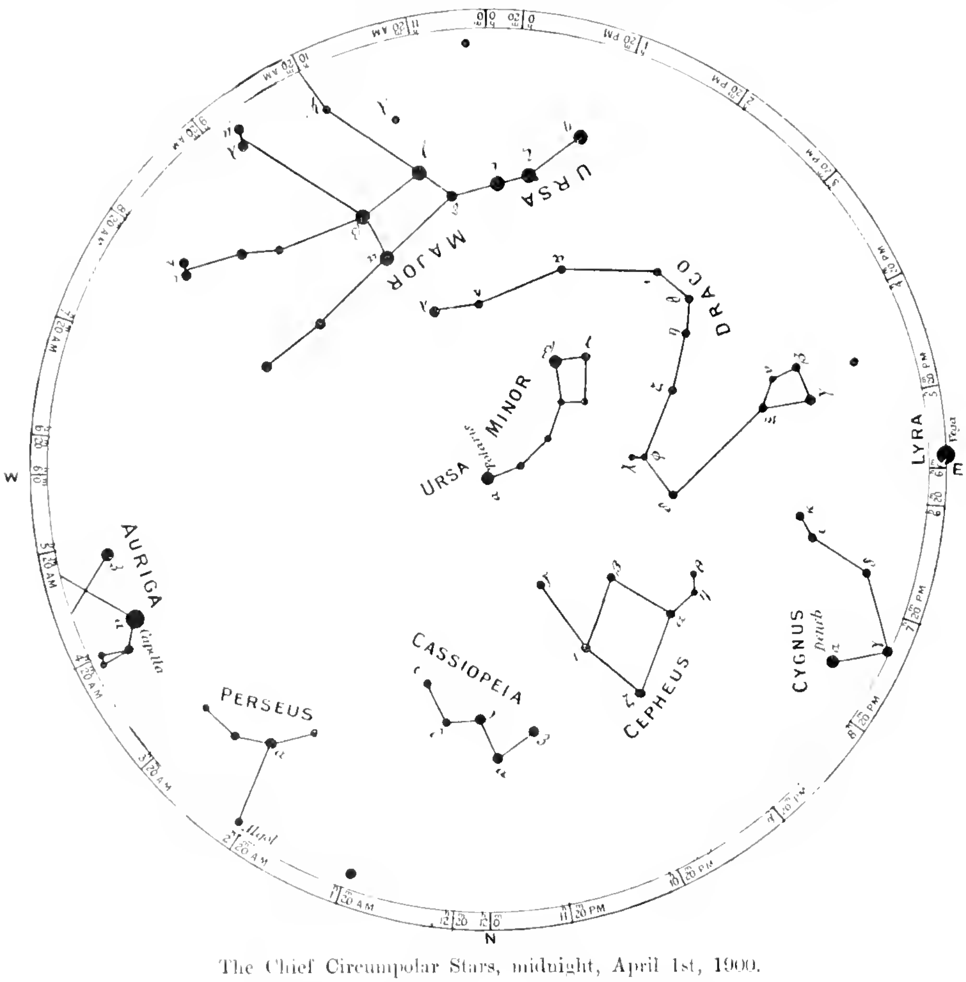
However often, therefore, the work of teaching the constellations may have been undertaken, it forms an inseparable portion of my present task.

To us in England, with our high northern latitude, the stars which never set are the first the study of which we should undertake. They are always present, they cover more than one-third of the entire sky visible to us at any moment. They include many conspicuous stars, and form an admirable guide to the constellations beyond the circumpolar region. Constantly revolving round the pole they form, as it were, a magnificent dial plate, marking at the same time the progress both of the night and of the year.

The chief constellation of this region is the Great Bear, the leading stars of which are the Seven, which have won the attention of all races of men in all ages. The seven stars of the Plough or Charles Wain (the waggon that is to say, of the churl or peasant) are known to everyone, and form the inevitable starting point for the study of the constellations. Of these seven stars,—which at midnight on the first of April are practically overhead, the greater part of the constellation being already on the downward path towards the west,—the two first are Alpha and Beta, the second pair Gamma and Delta, the four making up the body of the plough, whilst Epsilon, Zeta, and Eta form the handle. Delta is distinguished as being much the faintest of the seven, Zeta by its close companion Alcor visible to any ordinarily good sight. Alpha are commonly known as the "Pointers," for as the "poet" sings:

> "Where yonder radiant hosts adorn
> The northern evening sky,
> Seven stars a splendid glorious train
> First fix the wandering eye.
> To deck great Ursa's shaggy form
> Those brilliant orbs combine,
> And where the first and second point
> There see Polaris shine."

A straight line from Beta through Alpha points very nearly up to the pole of the sky, the distance being just a little greater from Alpha to the pole than from Alpha to Eta, and close to the pole shines the Pole star, a brilliant of the second magnitude, and placed at the end of the tail of the Lesser Bear as Eta is at the tip of that of the Greater.



The Chief Circumpolar Stars, midnight, April 1st, 1900.

Regarding the constellation as the "Great Bear," the four stars in the body of the Plough make the hindquarters of the animal, whilst the handle becomes the bear's tail. The feet of the bear are clearly pointed out by a curious set of three pairs, Iota and Kappa make the first, Lambda and Mu the second, Nu and Xi the third. These form the great plantigrade feet of the animal, and are "the does' leaps" of the Arabs.

A line drawn from Zeta through Alpha and carried forward the same distance the other side brings us to the fourth magnitude star Theta at the point of the creature's snout. These stars enable the boundaries of the constellation and the figure which it is supposed to represent to be easily detected in the sky. Beta and

The chief stars of the Little Bear, like those of the Greater, are seven in number, and in arrangement form a rough and fainter copy of the Plough. Between the two bears it is easy to trace out an irregular winding line of fairly bright stars. This is the Dragon the Serpent of the following lines from "Aratus":

> "Between these two, like to a river's branch,
> A mighty prodigy, the Serpent twines
> Its bendings vast around; on either side
> His coil they move and shun the dark blue sea.
> But o'er the one his lengthy tail is stretched,
> The other's wrapped in coil."*

Alpha Draconis, sometimes called Thuban or Rasta-

* Brown's "Aratus," p. 16.

ban, lies midway between Zeta Ursæ Majoris and Gamma Ursæ Minoris.

Starting from Epsilon Ursæ Majoris, the star in the Great Bear's tail nearest the root, and crossing the North Pole, we find on the further side of the Pole, right upon the sparkling background of the Milky Way, here almost at its broadest, five stars in the shape of a W, the principal stars of the constellation Cassiopeia, the "Lady in her Chair." At midnight on the first of April, this group is low down in the north; the W being, as it were, written in a dropping line from left to right, that is from west to east, as if scrawled by a tired writer. The lettering of the stars is nearly but not quite in the reverse order of writing. Reading from left to right they come Epsilon, Delta, Gamma, Alpha, Beta, the three last named being distinctly brighter than the other two.

Starting from Cassiopeia, and following the Milky Way towards the west, we find a number of stars marking out the spine of the Galaxy, and bending down in an elegant curve to the bright somewhat yellow star in the north-west. The stars in this curve are the principal members of the constellation Perseus, and the bright yellow star at the end of the curve is Capella, Alpha in the constellation Auriga. It is a star impossible to mistake, since close beside it is a very pretty little right-angled triangle of moderately bright stars.

Following the Milky Way towards the east, we find a bright star in the centre of the Galactic stream and about as far from Cassiopeia on the east as Capella is on the west. This is Deneb, Alpha in the constellation Cygnus, and it forms the head of a magnificent cross of stars. A little further along the Galaxy we come to another star not quite so bright, but of a slightly warmer tinge. This is Gamma, the star which marks where the two beams of the cross intersect. Above and below Gamma are other stars, making up a magnificent curving line, the transverse beam of the cross, or, if we prefer so to regard it, the upper outline of the outstretched wings of the Swan. A straight line from Alpha through Gamma and along the spine of the Milky Way, leads through a succession of considerable stars to Beta, which marks the Swan's beak, or the root of the cross.

Somewhat above the Swan and further to the east, and making very nearly a right-angled isosceles triangle with Beta and Gamma, the right angle being at Beta, is a splendid steel blue star, Vega, the rival of Capella in brightness, the two being claimants for the premiership of the northern heavens. The five bright stars which wait upon Vega in its immediate neighbourhood, and of which the nearest, Epsilon, is a very close double to keen sight, make up with it the constellation of Lyra, a constellation which lies for the most part outside the circumpolar circle for the latitude of London.

The chief guiding stars, therefore, for the northern heavens, are the well-known Plough, the scarcely less distinctive little W of Cassiopeia on the opposite side of the Pole, and the two great brilliants between them on the right hand and on the left, Capella and Vega. All these are continually visible for Scotland and the North of England; for the southern part of our island Vega is lost for a short time when due north.

Only one important group among the northern constellations has now been left undescribed. This is Cepheus, the Ethiopian king, a constellation of no great brilliancy or distinctiveness, and lying between the Dragon and Cassiopeia; the feet of the figure are supposed to stand on the Pole of the sky.

The accompanying map shows the position of the circumpolar region with regard to the north horizon at midnight on the first of April. The figures ranged round the circumference of the map show the position of the north point of the horizon for hourly intervals of the day and night at that time of the year. For other dates in the year we can find its position nearly enough by remembering that for every month later in the year that we take we must also take two hours earlier in the evening to obtain stars in the same position, or if we take a single day later in the year then we must choose our time four minutes earlier.

EARTHQUAKE-SOUNDS.

By Charles Davison, sc.d., f.g.s.

The sound which accompanies an earthquake has rarely, if ever, been described more graphically than by an observer of the Charleston earthquake of 1886. He was at the time on the second floor of a lofty building in Charleston when his attention was "vaguely attracted by a sound that seemed to come from the office below, and was supposed for a moment to be caused by the rapid rolling of a heavy body, as an iron safe or a heavily laden truck, over the floor. Accompanying the sound there was a perceptible tremor of the building, not more marked, however, than would be caused by the passage of a car or dray along the street. For perhaps two or three seconds the occurrence excited no surprise or comment. Then by swift degrees, or all at once—it is difficult to say which—the sound deepened in volume, the tremor became more decided, the ear caught the rattle of window-sashes, gas-fixtures, and other movable objects. . . . . The long roll deepened and spread into an awful roar, that seemed to pervade at once the troubled earth and the still air above and around. The tremor was now a rude rapid quiver, that agitated the whole lofty, strong-walled building." Soon "the floors were heaving underfoot, the surrounding walls and partitions visibly swayed to and fro, the crash of falling masses of stone and brick and mortar was heard overhead and without, the terrible roar filled the ears and seemed to fill the mind and heart, dazing perception, arresting thought . . .", until at last "the uproar slowly died away in seeming distance. The earth was still, and oh! the blessed relief of that stillness!"*

Though the chief features of the earthquake-sound are described in the above extract, its character varies considerably in different earthquakes, in various parts of the area of one and the same earthquake, and even with individual observers in the same house. For several years I have paid special attention to the phenomena of earthquake-sounds† and have collected several thousand descriptions, the types of comparison employed belonging generally to one of the classes mentioned below. Occasionally, however, an observer is uncertain, and quotes alternative types which may belong to different classes. But often the resemblance is so close that he is himself deceived, and starts up from his chair to see the unexpected carriage pass.

(1) The most frequent references of all are to passing vehicles of various kinds, and, as a rule, to very heavy ones, such as traction-engines, steam-rollers or waggons,

* C. E. Dutton, Amer. Geol. Survey Ninth Annual Report, pp. 212-213.

† See a paper in the *Phil. Mag.* for January, 1900, of which the present paper is an abstract.

driven rapidly over stone paving or on a hard or frosty road: express trains or heavy goods trains rushing over an iron bridge or through a tunnel or cutting: or weighty furniture dragged along the floor. (2) Next in frequency come comparisons to thunder, occasionally to a deep peal, but most often, perhaps, to distant thunder. (3) In some earthquakes, but by no means in all, the sound appears to resemble a rough or moaning wind, the howling of wind in a chimney and a chimney on fire. (4) When it is of short duration and fairly uniform in intensity, we find the sound described as like that of a load of coal or bricks falling from a cart, or of a wall or roof tumbling down. (5) Again, when still briefer, it is compared to the thud of a ponderous weight, a large mass of snow or of heavy timber, or the slamming of a door. (6) In weak earthquakes, and above all in the slight after-shocks of a great earthquake, we have references to explosions of different kinds, but chiefly to colliery explosions, rock-blasting or the firing of artillery, especially when they occur at a distance. (7) Lastly, there are several descriptions of a miscellaneous kind, which are rarely used and do not fall under any of the above headings, such as the trampling of many animals, a covey of partridges on the wing, the roar of a waterfall or the rumbling of waves in a cavern.

To most observers and over the greater part of the disturbed area, the sound remains of the same character throughout. There is nearly always a very perceptible change of intensity, the noise growing gradually louder and then dying away, and the change sometimes takes place so uniformly that it seems as if a carriage were coming up rapidly to the door of the observer's house and afterwards receding on the other side. Close to the epicentre (or area vertically above the seismic focus), a change in the character of the sound is also noticeable at or about the instant when the shock is strongest; some hear a loud crash like the explosion of a bombshell; to others, it appears rougher and more grating; while a large number perceive no change at all. At moderate distances, the changes are much less marked, before and after the shock, the sound resembles the moaning of the wind, and, while the shock lasts, a more rumbling character is developed. At great distances, the change in character is hardly sensible: there is little, if any, variation in intensity, and the report, when heard, resembles more than anything else the deep boom of distant thunder.

The extraordinary depth of the sound is shown very clearly by the descriptions given above. The frequent and unprompted use of the word "heavy," whether applied to thunder, explosions, or traction-engines, is some evidence of this. The same impression is also conveyed by the more detailed accounts; "much lower than the lowest thunder" one observer writes, and another, "I can only compare the sound with the pedal notes of a great organ, only of a deeper pitch than can be taken in by the human ear, shall I say a noise more felt than heard?" Still more striking is the fact that, while the sound is heard by some observers, it is quite inaudible to others at the same place and even in the same house. To one person the sound is so loud that it seems like the rumbling of a heavy traction-engine passing; another in the same place and equally on the alert will be just as positive that the shock was unaccompanied by sound. The explanation offered rather confidently by some writers that the attention of the second observer was distracted by the shock is untenable for several reasons, which may be worth mentioning. (1) In the first place, the sound is often too loud to escape notice in this way. (2) It is generally heard before the shock begins to be felt. (3) Different races, as will be seen afterwards, vary much in their powers of hearing the earthquake-sound. A whole nation, and especially one so accustomed to observing earthquakes as the Japanese, cannot be accused of constant inattention. (4) Lastly, my own hearing is, I believe, unusually keen for ordinary noises, but I could hear no sound during the Hereford earthquake of 1896, though I was in a quiet room and listened intently, and more than 60 per cent. of the observers in Birmingham heard the earthquake-sound. We may therefore conclude that the inaudibility of the sound is not due to inattention, but simply to the fact that some observers are deaf to very low sounds.

Another fact deserving of notice is that the sound-vibrations are not all of one pitch. The loud and deep explosive crashes observable near the epicentre at the time when the shock is strongest are only heard by some persons. Again, the observers at any one place make use of widely different means of comparison. Thus, out of more than fifty observers of the Hereford earthquake in Birmingham, 35 per cent. compared the sound to passing waggons, etc., 18 per cent. to thunder, 17 to wind, 4 to loads of stones falling, 9 to the fall of heavy bodies, 11 to explosions, and 6 per cent. to miscellaneous sounds. The difference in loudness was also very marked. On the one hand, we have such descriptions as a traction-engine passing, an express train rushing beneath an arch, a heavily laden cart passing over a rough street, and heavy thunder; on the other, distant thunder, a rushing wind and a very distant explosion. If all the observers in one place were equally endowed, the sound would present the same character to every one of them. But their powers differ widely. Their ears, indeed, act like sieves of varying degrees of fineness; some are affected by many vibrations and to them the sound is loud and complex; others are impervious to all but a few vibrations, and they hear a sound that is apparently faint and monotonous.

As the inhabitants of any one country do not agree in this respect, it is only natural to suppose that different races should also vary. The people of Great Britain seem to have unusually good powers of hearing earthquake sounds. It may fairly be said that an earthquake never occurs in these islands without the sound being heard. It is not altogether easy to make a just comparison with other nations, for we cannot be certain that the omission of sound-records is not accidental. There are, however, two countries, Italy and Japan, where earthquakes are closely studied. In Italy about one-third, and in Japan about one-quarter, of the earthquakes seem to be accompanied by sound. But there is this difference between them. The Italian shocks, which are unattended, so far as we know, by sound, are generally felt by very few persons; when there are many observers, there are always one or more to be found among them who are capable of hearing deep sounds. But, in Japan, although the proportion of audible earthquakes increases with the area shaken by them, nearly one-third of the strongest shocks are unaccompanied by any recorded sound. The only inference we can make from this is that the Japanese, as a race, are less susceptible than Europeans to very low sounds.

The more or less limited size of the area over which the sound is heard is also evidence of the less or greater deafness of observers for low sounds. In Great Britain, the sound is heard with every earthquake, and by a large proportion of the observers who feel the shock; and here the sound-area is always large. In weak earthquakes, the noise is heard further than the shock is felt; in strong ones, it has been heard as far as 180 miles from the epicentre. In Japan, on the other hand, the sound is inaudible at a distance of a few miles from the epicentre. Of the earthquakes which originate beneath the land, about one-quarter are accompanied by sound; while this is the case with less than one per cent. of those which have submarine foci, although more than nine-tenths of the epicentres were not more than ten miles from the coast. Indeed, so deaf are the Japanese to the earthquake-sound that it is probably heard by them only in the case of those shocks which originate at a very slight depth below the surface of the ground.

In all countries, however, the sound-area is less than the disturbed area of a strong earthquake; and in a disastrous earthquake it may occupy only a comparatively small region in the neighbourhood of the epicentre. But there is no constant relation between the two areas; for, in moderately strong or weak earthquakes, they nearly coincide, or the sound-area even overlaps the other on one or more sides; while, in a very weak earthquake, it overlaps it in all directions. Moreover, there are some very interesting cases in which the disturbed area ceases altogether to exist, that is, the sound is heard while no shock whatever is felt.

That such earth-sounds have the same origin as ordinary earthquakes is highly probable. They are heard in districts where slight shocks are frequent; and sometimes a series of earth-sounds is interrupted by a shock accompanied by a precisely similar noise. A great earthquake is always followed by a crowd of after-shocks, among which earth-sounds occur in great numbers at places near the epicentre. It would therefore seem that earthquakes and earth-sounds may be traced to the same cause, that the chief difference in reality lies in ourselves, in the sense by which we perceive them—in other words, that an earth-sound is merely an earthquake too weak to be felt.

A point of some importance is the relative position of the sound-area and disturbed area of an earthquake. So far as known, the two areas never have the same centre. Their longer axes are parallel to one another, but the sound-area is always displaced with respect to the other, sometimes in the direction of the longer axis, but generally in that of the shorter axis. In the latter case, moreover, the displacement takes place towards the line of the fault with which the earthquake appears to be connected, implying that the loudest sound-vibrations do not come from so deep-seated a portion of the fault as the vibrations which constitute the earthquake-shock.

In old earthquake catalogues, the sound is generally said to precede or accompany the shock, very rarely to follow it; in Japan, the sound is seldom, if ever, heard after the shock ceases to be felt, but it is nearly always heard before the shock begins. We may fairly infer from this that the fore-sound is louder than the after-sound. More detailed studies of recent British earthquakes show that the beginning of the sound generally precedes that of the shock in all parts of the sound-area; while the end of the sound more frequently follows that of the shock than otherwise, even at very great distances from the centre. In weak earthquakes, the instant when the sound is loudest always coincides with that when the shock is strongest; and this is generally, though not always, the case with strong earthquakes. The duration of the sound is as a rule obviously greater than that of the shock.

In order to give definiteness to the explanation of the phenomena described above, I will assume the truth of the theory which ascribes non-volcanic earthquakes to the friction produced by the sliding of one of the rock-masses adjoining a fault over and against the other. The seismic focus in such a case must be a surface inclined to the horizon, and the relative displacement of the two rock-masses will be greatest near the centre of the focus and will die away towards the edges. Thus, from all parts of the focus, there must proceed vibrations differing in amplitude and period, the large and slow vibrations coming from the central region, and the small and rapid ones from the margins. It is the latter, I believe, especially those which come from the upper and lateral margins, which are responsible for the earthquake-sounds.

It is evident, on this view of their origin, that the sound will become gradually louder until the shock is felt, and afterwards die away. The intensity of the sound will also increase with that of the shock in different earthquakes; but while the marginal vibrations are limited in amplitude and period, those from the central parts of the focus have a wider range, and therefore the intensity of the sound will not be proportional to that of the shock. Similarly, in a violent earthquake, the disturbed area will extend far beyond the sound-area; while, in a weak earthquake, the latter area will overlap the former. In the limit, the central region of the focus will vanish, and the sound will be heard without any accompanying shock.

The most perceptible sound-vibrations will be those which come from the upper and lateral margins of the focus, and the boundary of the sound-area, with respect to that of the disturbed area, must therefore be shifted towards the fault-line, and also in the direction of the fault if one lateral margin be longer horizontally than the other.

The sound-vibrations from the margin nearest to the observer will be heard before the shock begins, those from the upper margin and the central region during the shock, and those from the furthest margin after the shock ends. Thus, the fore-sound, on account of its nearer origin, will be more generally noticed than the after-sound; and, for the same reason, will be the only sound heard by Japanese observers. The after-sound will be less frequently heard as the distance from the origin increases; and the duration of the sound, especially at places near the epicentre, will be greater than that of the shock.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

IS THE UNIVERSE INFINITE?

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The letters of some of your correspondents, including Mr. Inglis, the latest of them, leads me to suggest a form of the above problem which will keep us clear of the theoretical difficulties about infinity. I would therefore substitute, Does the stellar universe extend to 1,000 times the average distance of a star of the sixth magnitude?

The answer seems to me to be, Certainly not, unless (1) there is a medium in space which absorbs light, or

(2) a rapid thinning-out of the stars as we proceed to a great distance from the sun, or (3) a rapid decrease in the luminosity of the stars—which would have the same effect as a decrease in their number.

Taking the successive members of our series as the stars of each successive magnitude, it would be an increasing, not a decreasing, series, on the assumption that the distribution of the stars was uniform, and that there was no absorptive medium. Adopting Pogson's scale, the total light of the stars of the n+1th magnitude would always be equal to 1.585 times the total light of the stars of the nth magnitude. Can any reasonable man who looks at the sky imagine that this process is carried as far as the stars of the 1000th magnitude?

What light an infinite number of stars situated at an infinite distance might or might not give us is an insoluble problem. I only profess to deal with stars at finite distances. The main question is whether there is a gradual thinning-out of these as we proceed to great distances from the sun. I hope your future correspondents will confine themselves to this issue.

The distance of the sun from its nearest neighbour and Centauri is so vast that many persons seem to conclude either that we do not belong to the Galactic System or that we are situated in a void space in the Galaxy. I cannot see that either of these alternatives has been proved. The sun, so far as I can judge, is very probably a Galactic Star situated in a region which is neither unusually dense nor unusually rare. If so, a great diminution in the density of the stars may be expected when we once get outside of the Galactic Cluster. The stars outside of it may, notwithstanding, extend to infinity or even be infinite in number, but then much more sparse distribution outside of the Galactic Cluster would account for what we see.

The Galaxy, as we see it, is nearly a great circle on the sphere. This fact suggests that the sun (and earth) is in it, not outside of it—if indeed the galaxy is not a hollow ring near the centre of which we are situated. But the gradual decrease in the density of the stars as we proceed towards the Poles of the Galaxy is hardly consistent with the theory that the sun occupies an open space in the centre of the ring. There may have been something in the old idea that the earth was the centre of the Universe—viz., that it is one member of vast central constellation, and may therefore be regarded as the actual centre when the distance considered is sufficiently great. W. H. S. MONCK.

P.S.—When I first wrote on the subject I fell into the same error as Mr. Inglis, viz., that on the hypothesis of uniform distribution the total light of the stars of the nth and n+1th magnitude would be the same. I made this mistake in consequence of considering the surface of the sphere instead of its solid contents. I was fortunate enough to be the first to point out the error into which I had fallen. But I am afraid that I am theorising too much for your reviewer.—W. H. S. M.

IS THE STELLAR UNIVERSE FINITE?

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Mr. Monck writes: "Bright stars lose as much by absorption, atmospheric or telescopic, as fainter ones. Individually they do not lose the same proportion of their total light which is the essential point so far as my argument is concerned. A faint star becomes invisible near the horizon, while a bright star still remains visible at a similar altitude. Although the combined light of a number of stars too faint to be separately visible may certainly, as he points out, produce the sensation of light, yet if the atmosphere absorbs so much of the light of each individual star as to render it invisible as such, then none of those stars are included in the counts or gaugings of stars on which Mr. Burns relied, although they might actually exist. Conclusions, therefore, based upon these counts, absorption being neglected, appear to me to be erroneous.

WM. ANDERSON.

Madeira, February 12th, 1900.

THE CONSTITUENTS OF THE SUN.

TO THE EDITORS OF KNOWLEDGE.

[I was wrong, no doubt, in writing "dark," seeing that the laboratory spectrum of carbon consists of bright lines. But even if we deal with these bright lines or flutings, I still maintain that the coincidence of all of them with dark solar lines is not made clear to me in Fig. 3. I admit that the fluting beginning at 3879 and ending at 3883 corresponds generally with that in the solar spectrum, but the break or change in continuity shown in the latter at about 3882 does not appear in the carbon spectrum; neither does the abrupt termination of the fluting coincide exactly in position with that of the dark. Then, again, as to the beautifully regular fluting commencing at 3874 and ending at 3878, there may be a dark line corresponding in position to each of the brighter, but the general character of the fluting is by no means represented on the dark lines—that is to say, the very slight but regular crowding together of the lines towards the right. Similarly at wave lengths lower than 3874, no particular correspondence suggests itself to my eye. I do not deny that there is a correspondence between the lines of carbon generally, with dark lines in the sun; I merely reiterate that the figure in question does not, to me, give that convincing visual coincidence which the text-books lay stress upon as proving beyond possibility of doubt the existence of certain elements in the sun.—E. E. M.]

[To my former remarks I need only add that in the solar spectrum the flutings of carbon are superposed upon lines due to various other elements, so that except in the case of the fluting commencing at 3883, the correspondence with the arc spectrum of carbon is not very striking. Nevertheless, Rowland finds that 145 of the solar lines between Lambda 3883.5 and Lambda 3864.0 agree with the component lines of the carbon flutings. In the diagram I indicated only the most obvious of these coincidences, and showed also that the break in continuity at 3882 was due to the presence of a line of cobalt.—A. F.]

Notices of Books.

"The Races of Man; an Outline of Anthropology and Ethnography." By J. Deniker. Contemporary Science Series. (Walter Scott, Limited.) A popular work on his favourite science by such a distinguished anthropologist as Dr. Deniker, the Chief Librarian of the Paris Museum of Natural History, can scarcely fail to be a masterly treatise on the subject, and should merit the best attention of his fellow-workers in this country, even if they be disposed to doubt the correctness of some of his views. As its title implies, the work treats of man not only from a zoological, but likewise from a physiological and sociological standpoint, so that it deals with anthropology in its most comprehensive sense, the greater part of a chapter being devoted to language and its evolution. No less than 170 illustrations—some of full-page size—are employed to convey an adequate idea of the leading types of mankind, and the mode of dress (or "undress") of the various races. The care with which these illustrations have been selected, and the excellence of their execution, will scarcely fail to be appreciated by those who know how difficult it is to obtain a good series of representative types. In the introduction the author treats of the difficulty felt by all anthropologists in dealing with man from a systematic point of view; "species" and "races" being in his case scarcely comparable with the sense in which those terms are used in ordinary zoology. He next proceeds to show in what respect man differs from or resembles apes and monkeys: from which he is naturally led on to the consideration of the distinctive characters of the various races of mankind. Physiological characteristics, inclusive of cross-breeding and the cosmopolitanism of man, next claim attention; after which we find four chapters devoted to language and sociology. In this latter section of the subject is embraced all connected with man's individual and social life; and we learn how dress has been gradually evolved from ornament, the manner in which social organization has developed, the evolution of the complicated commercial system of the present day from the original barter, and, in fact, all that has to do with the formation of society, so far as is possible in the space at the author's disposal. In the eighth chapter, Dr. Deniker comes to the classification of the various races of mankind; while the remaining five chapters treat in detail of the races and peoples of the various continents and archipelagoes of the world. In his classification of mankind the author lays great stress upon the character of the hair as a feature of prime importance, giving a table explanatory of the manner in which he proposes to arrange the different races according to this standard. While the system thus formulated presents a very considerable agreement with the one so largely adopted by English anthropologists of the present day, it lacks the brigading of the races into three or four primary stock-groups, and is therefore, in our opinion, likely to confuse the general reader, who will find it somewhat difficult to grasp the author's conception of the mutual relationships of the various races. We are, however, pleased to find that the view recently expressed in Knowledge as to the wide gulf between the aboriginal tribes of Australia and Negroes, and the affinity existing between the former and the inferior races of India and Ceylon, also commends itself to the author of the volume before us. As a matter of fact, all the races classified by Dr. Deniker as "woolly-haired" correspond to the Negroid stock (minus the Australians) of the late Sir William Flower's classification; his curly and wavy-haired races to the Caucasian, and the straight-haired races, which include the Mongols and American Indians, to the Mongoloid stock. The separation in the table of the South American from the North American races is, however, to be regretted; as is likewise the author's disinclination to recognise the Malays as a distinct race. It may also be mentioned that his usage of the term "Indonesians" seems scarcely justifiable, since it was framed to include all the inhabitants of the Malayan Islands and Oceania, coming under the designation neither of Melanesians nor Malays, and yet we find Dr. Deniker retaining the designation of Polynesians for the Samoans and their kindred. To follow the author into the detailed description of the races and tribes of the various continental and insular areas of the globe, would be impossible within the space at our command. But it may be mentioned that he is very sceptical not only as to whether there were ever an "Aryan" people, but even as to the existence of a corresponding language. It is likewise noteworthy that he employs the term "Ethiopians" for the Hamitic races of North-east Africa, and if, as is very probably the case, this usage is correct, it may be a matter for consideration whether we are justified in continuing to employ the designation "Ethiopian region" for Africa, south of the Sahara, as is so generally the practice in zoo-geography. In the case of a foreigner the error of "Black Continent" instead of "Dark Continent" (p. 427) is perhaps excusable; but the perpetuation of such an obsolete title as Cervus tarandus (p. 305) for the reindeer is not so easily pardoned. While fully appreciating its many excellent features, we would recommend anthropological students not to confine their attention to this volume, but also to read works like those of Professor A. H. Keane, in which somewhat different views are expressed. They will thus be in a position to take the via media in cases of doubt and difficulty.

"The North American Slime-Moulds." By Thomas H. Macbride, A.M., PH.D. (New York: The Macmillan Company.) 10s. net. The Myxomycetes, or Slime-moulds as Prof. Macbride prefers to call them, have recently been introduced to readers of Knowledge through the interesting papers by Sir Edward and Miss Agnes Fry which appeared during 1899. These authors have made the organisms familiar to us under the much prettier name of "myxies." The myxies are at the two important stages of their life-history totally different in character. During the growing, or vegetative, phase they are merely undifferentiated masses of protoplasm hardly distinguishable from an ordinary amœba. Indeed, in some systems of classification they have, at this stage of their growth, been placed in the animal kingdom. It is thus perceived that Prof. Macbride's volume is concerned with the interesting borderland which by some authorities is claimed for the kingdom of zoology and by others for the realm of botany. But whether after a short or longer period of time the fruit, or reproductive phase, in the life of the myxomycetes at last arrives, and is accompanied by a total change of characters. The organism seeks the light, and the object now to be attained is not only the formation of spores, but the rapid drying up of the parent and the effective distribution of the fruit. The author describes how this desiccation sometimes occurs suddenly "as if by magic charm into one widespread, dusty field of flying spores." With reference to the perennially interesting question as to whether the slime-moulds are plants or animals, Prof. Macbride says, "Why call them either plants or animals? Was Nature then so poor that forsooth only two lines of differentiation were at the beginning open for her effort? May we not rather believe that Life's tree may have risen at first in hundreds of tentative trunks, of which two have become in the progress of the ages so far dominant as to entirely obscure less progressive types?" Dealing with the same problem in Knowledge of January, 1899, Sir Edward Fry remarked of the myxies, "their locomotion and rapacious youth seem to shut them out from the plants; their stationary condition and their production of sporangia from the animal world." But these fascinating subjects form only the introductory part of the book before us, the function of which is to provide a list of all species of the myxomycetes hitherto described from North and Central America. The volume is essentially one for the serious student, who will find in it an authoritative account of the present state of knowledge in this department of biological science.

"The Letters of Faraday and Schonbein (1836 to 1862). With Notes, Comments, and References to Contemporary Letters." Edited by Georg W. A. Kahlbaum and Francis V. Darbishire. (Williams and Norgate.) 13s. net. It is a little difficult for the ordinary student of chemistry who is in the habit of finding, by merely referring to some text-book or dictionary of his subject, the answer to each difficulty which presents itself in the course of his work, to change places in imagination with pioneers like Faraday and Schonbein, who, though studying subjects familiar to many schoolboys to-day, were able to discover no ready-made answers, but were entirely dependent upon what they could find out by their own experiments. Nevertheless, the excitement of discovering things for themselves they certainly had, and there is evidence in abundance, in their letters, that they thoroughly enjoyed it. The reader catches some of their enthusiasm in following the rather frequent letters which passed between the philosopher at the Royal Institution and his Swabian contemporary at Bâle. As the separate steps in Schönbein's researches on passive iron and ozone—to take only two of many examples—are duly explained in letters to Faraday, the reader, in spite of himself, begins to wonder what direction the researches will take in the next communication. Faraday was already lecturing at the Royal Institution when Schonbein was a young student, and though the latter was once, when visiting England, actually present at a Friday evening lecture, he was too shy to speak to Faraday after the lecture. It was not until some years later, when Schönbein was actually engaged at Bâle on his investigations respecting the action of nitric acid on iron, that he wrote to inform Faraday of some of the phenomena he had observed. Later they became personally acquainted. These letters are not only valuable, however, as a history of certain parts of nineteenth century chemistry, they will, it is to be hoped, be read also for the delightful picture they reveal of the almost brotherly fondness for one another which can exist between two actively engaged men of science. The intimate acquaintance one seems to acquire with Faraday's personality by reading these letters will well repay the student who takes up the volume. It is a sad story which Faraday has to unfold about himself in many of his letters. Frequent ill-health and constant loss of memory had to be reckoned with, and when we remember the amount of work Faraday accomplished, we can form a rough estimate of his steadfastness of purpose and devotion to science. The editors have done their work well—their notes supply just those links which are necessary to enable the reader to properly appreciate the letters.

"The Mind of the Nation: a study of political thought in the Nineteenth Century. By Marcus R. P. Dorman. (Kegan Paul & Co., Limited.) 12s. This is a substantial essay of some 500 pages on the constitution and government of the United Kingdom, written from the standpoint of the superior person who knows all about it. It follows as a matter of course that the writer's opinion, of his fellow countrymen, whose political genius has always excited the admiration of the world, is of the poorest. "No one could maintain," he says, "that more than five per cent. of the voters have any real knowledge of politics at the present time." We are not, of course, concerned to canvass this proposition, but if it is true we fear that the proportion is not likely to be increased by a study of Mr. Dorman's book, which is marred both by loose statement and obvious bias. What are we to make, for instance, of his criticism of the practice of questioning ministers in Parliament, a practice which has been found of the very greatest utility by ministers themselves, and which the writer thinks should be stopped. Wherever this practice is abused the remedy is clearly in the minister's own hands, and, further, is frequently applied. But what is to be said for a teacher in parliamentary practice who appears to be labouring under the delusion that ministers are in the habit of putting down questions addressed to their own colleagues (page 288). Here he has been relying, as Sheridan said, on his imagination for his facts. Then, again, the statement that Peel was enabled to carry his measure for the repeal of the Corn Laws because he was supported by a sufficient number of his own followers is quite at variance with the fact that some 250 of them voted against him. And the compiler of the Peel papers is surely Mr. C. S. Parker, sometime and a long time member for Perth, and not Mr. J. S. Parker. The book may be commended to those who are able to apply the necessary corrective, but it will not further the knowledge of the student in history, or the understanding of the citizen in the form and practice of the Constitution

"The Grammar of Science." By Karl Pearson, M.A., F.R.S. (A. & C. Black.) 7s. 6d. net. This is a second edition of a most important work which has been thoroughly revised and much enlarged. Two entirely new chapters on Natural Selection and Heredity, embracing a popular account of Prof. Pearson's own more recent work in this direction, have been added. There is a peculiar opportuneness about the appearance of a new edition of this clear exposition of the scientific method and the claims of science to be regarded as the educational instrument, par excellence for a training in citizenship. The inauguration of the new Board of Education which is to be immediately effected will focus attention upon the claims of the different schools of thought to be regarded as the final courts of appeal in questions of pedagogic expediency. We can conceive of no more convincing advocacy of the peculiar fitness of a training in the methods of science as a preparation for active life than is accorded by this volume. The function of science is, to use Prof. Pearson's words, "the classification of facts, the recognition of their sequence and relative significance." And, again, "modern science, as training the mind to an exact and impartial analysis of facts, is an education specially fitted to promote sound citizenship." Other claims of science are set forth in the same luminous manner. The light science brings to bear on many important social problems, the increased comfort it adds to practical life, and the permanent gratification it yields to the æsthetic judgment, are all reviewed in an equally masterly fashion. The important part which science must take in human development makes it an imperative necessity to have the fundamental concepts of modern science enunciated with logical clearness, and Prof. Pearson's criticisms of eight years ago, with the additions of to-day, can have nothing but a salutary effect in making men of science themselves more rigidly scientific. We have been again and again impressed in examining "The Grammar" with the remarkable lucidity of Prof. Pearson's explanations. The educated person, whatever the particular branch of knowledge with which he is familiar may be, will have no great difficulty in following the arguments here set forth, provided only that he commences his study with an open mind and a teachable spirit. We sincerely hope that another eight years will not elapse before the third edition is called for.

"Experimental Physics." By Eugene Lommel. Translated from the German by G. W. Myers. (Kegan Paul.) 15s. net. The reader who is familiar with modern British books on experimental physics will be disappointed if he expects to find in Prof. Lommel's treatise what is now considered to be an experimental treatment of the subject. The book is descriptive rather than experimental, and it contains no specific instructions to the student for enabling him to perform the experiments on which our knowledge of physical forces depends. For other reasons, too, the translation of the German volume seems superfluous. The same subjects are explained, and, we are bound to confess, better explained, in several other books already familiar to teachers. Nor is the volume better illustrated and more up-to-date than those we have in mind. There is, moreover, a growing disposition to discourage the use of these general reviews of the whole domain of physics, and to substitute more specialised accounts of the main branches, so that we are compelled to say that the book is unnecessary, and cannot be recommended either to teachers or students.

"Journal of the Society of Comparative Legislation." Edited by John Macdonell and Edward Manson. New Series. No. 3. (John Murray.) 5s. The third volume of this invaluable work is distinguished by a full and detailed review of the legislation of the British Empire in 1898, to which Sir Courtenay Ilbert contributes an introduction. Among the subjects dealt with by experts on constitutional law and general legal topics will be found an article by Mr. A. Wood Renton on "Indian and Colonial Appeals to the Privy Council"; a paper on Suzerainty," by Mr. W. P. B. Shepheard; and an instructive comparison of Truck Legislation in England and on the Continent, by Miss A. M. Anderson, one of Her Majesty's Inspectors of Factories. The writer of the valuable notes at the end of this volume makes an interesting comparison of the legislative procedure in our House of Commons and in the French Chamber of Deputies, not always to the advantage of our method. In the French Chamber, however, it is undeniable that the House itself does not enjoy the same control of legislative projects that is possessed by the House of Commons.

For the accommodation of persons wishing to view the Eclipse of the Sun, which takes place on Monday, May 28th next, Messrs. Cook have arranged a conducted tour, leaving London May 21st, visiting Paris, Bordeaux, Biarritz, Madrid, and Talavera, where the total phase of the eclipse will be visible.

BOOKS RECEIVED.

Recent and Coming Eclipses. Second edition. By Sir Norman Lockyer. (Macmillan.) 6s.

Wireless Telegraphy. Fourth edition. By Richard Kerr. (Seeley.) 1s.

Horns of Honour. By Frederick Thomas Elworthy. (Murray.) Illustrated. 10s. 6d. net.

Object Lessons in Botany. By E. Snelgrove. (Jarrold.) 3s. 6d.

Practical Zoology. By T. J. Parker and W. N. Parker. (Macmillan.) Illustrated. 10s. 6d

Remarkable Eclipses and Remarkable Comets. By W. T. Lynn. (Stanford) 6d. each.

The Naturalist's Directory for 1900. (L. Upcott Gill.) 1s. 6d. net.

Life of Dr. Arnold. By Dean Stanley. (Ward, Lock.) 2s.

The Story of the Nations—Modern Italy. By Pietro Orsi. (Unwin.) 5s.

The Flowering Plant. By J. R. Ainsworth Davis. (Griffin.) Illustrated. 3s. 6d

Ferric and Heliographic Processes. By George E. Brown. (Dawbarn and Ward.) 2s.

Flowers of the Field. By Rev. C. A. Johns. (S. P. C. K.) Illustrated. 7s. 6d.

Chatty Object Lessons in Nature Knowledge. By F. W. Hackwood. (Longmans.) 3s. 6d.

Technical Education Returns in England, Wales, and Ireland. (Eyre & Spottiswoode) 1s.

The Studio: an Illustrated Magazine of Fine and Applied Art, March, 1900. 1s.

Tools and their Uses, Repoussé and Metal-Chasing, Turning Lathes. "Useful Arts and Handicrafts Series." Dawbarn & Ward.) 6d. each.

The Norwegian North Polar Expedition, 1893—1896, Scientific Results. Edited by Fridtjof Nansen. Vol 1. (London: Longmans, Green & Co.) 40s.

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Bittern in Devonshire.—This neighbourhood participated in the flight of Bitterns which seems to have visited England this winter. On January 18th, when walking on our marsh bank, a Bittern rose within a few yards of me. It appeared in a very weak state, and after flying a short distance plumped into the tall reeds fringing the bank. I left him undisturbed, and as some days afterwards a Bittern was seen flying across the river here, I hope he has escaped destruction. I learn that one was killed in the marsh just outside Exmouth, on January 23rd. The last great flight of Bitterns in Devonshire was in the winter of 1890-91.—W. S. M. D'Urban, Newport House, near Exeter.

Winter Visitors to Devonshire.—On the 11th December, 1899, a great movement of birds took place from the eastward, and there was a great influx of lapwings, golden plovers, ducks, coots, water rails, snipe, dunlins, mistle thrushes, chaffinches, starlings, larks, and ring doves, into South Devon. There was a severe frost on the 14th and 15th, followed by a south-westerly gale on the 16th. About this time there was a run on the holly-berries, and they were soon cleared off by the mistle thrushes and ring doves, which filled their crops almost to bursting with them. There was another influx of birds on 15th January, 1900, when vast flocks of lapwings again showed themselves, and ring doves, coots, and wild ducks again became numerous. On 26th January, song thrushes appeared in astonishing numbers on grass fields, and the bushes in the shrubbery after dark were alive with them. Blackbirds, mistle thrushes, and starlings also became very plentiful. When the frost set in on February 8th, redwings became extremely plentiful here, feeding amongst the undergrowth in the wood. Fieldfares were not numerous here, but Mr. E. A. S. Elliot informs me that after the heavy snow storm on the 13th, they appeared in extraordinary numbers at Kingsbridge. Lapwings and redwings became extremely weak here, and the latter fell an easy prey to cats and sparrowhawks.—W. S. M. D'Urban.

Wild Robins as Pets.—Last summer we remarked some young Robins in our garden, which seemed inclined to become familiar, and sitting out daily in my Bath chair I amused myself feeding them, and very soon induced two or three of them to take crumbs from my hand. One in particular became so tame that my daughter suggested trying him with pieces of biscuit held between the lips, and after one or two trials he came quite freely, flying from greater distances each day, and poising like a hawk moth before snatching the morsel from our lips. This became a regular game with the bird, and two of his companions soon followed his example, and took biscuit from our lips, when they had quantities of other food dug up by the gardener. I am sorry to say our six pet Robins fight furiously, and a hen Blackbird often watches for, and secures the crumbs they let fall.—Frances T. Battersby, Cromlyn, Rathowen, W. Meath.

Egg Inclosed in Another.—A friend has recently sent me two eggs laid by one of his pigeons. One of them is of unusual size ($2\frac{1}{4}$ inches in length), the other a little less than $1\frac{1}{2}$ inches in length, i.e., a little under the normal measurement. The small egg was found inside the big one. This is the only instance that has come to my notice of one egg being enclosed within another egg.—F. W. Headley, Haileybury.

[A similar occurrence in the case of a fowl's egg was reported in the 'Field' for September 2nd, 1899, when the Editor made the following remarks:—"The occurrence is uncommon if considered in proportion to the number of eggs laid, probably one in many thousand; nevertheless, a year rarely passes that we do not receive a specimen. The explanation of the curiosity is as follows: Normally, the yolk, as it passes down the long oviduct, is enveloped in the concentric layers of the white, then the membrane, and finally the shell. If, in place of being extruded, an abnormal reversed action of the oviduct takes place, the egg is carried back, and meeting with a second descending yolk, both are included in the outer coverings, and one egg within another results."—H. F. W.]

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Obituary.

Astronomy—more particularly the domain of celestial chemistry—is the poorer by the loss of Charles Piazzi Smyth, formerly Astronomer-Royal for Scotland. The son of Admiral W. H. Smyth, he was born at Naples, 3rd January, 1819. Called "Piazzi" after the discoverer of Ceres, he early took to the science, and became assistant at the Cape Observatory at the age of sixteen. In 1845, at the age of 26, he became Astronomer-Royal for Scotland, beginning his work with great anticipations which, alas! were destined to be congealed in a frigid sea of officialdom. After more than forty years' service he retired to Clova, near Ripon, protesting against the degenerating influence of red-tape. In retirement the ex-Astronomer-Royal devoted himself to the photographic study of the solar spectrum and of cloud forms. He gave the first detailed descriptions of the telluric bands; introduced the "end-on" mode of viewing vacuum tubes, and adverted to the significance of the "rainband" for weather prediction. While at Edinburgh he reduced and published his predecessor's (Henderson) observations; installed, in 1855, a time-ball on the Calton Hill, and compiled an extensive star-catalogue. At Teneriffe, in 1856, he studied the quality of astronomical "seeing" at high levels, notwithstanding the persistence of "dust-haze" to a height of 11,000 feet. In 1882, at Madeira, he investigated the solar radiations with a fine Rutherford "grating." "Life and Work at the Great Pyramid," published by Smyth in 1867, exhibits a phase of thought which provoked much controversy at the time and led to the author's resignation, in 1874, of the Fellowship of the Royal Society. The Great Pyramid was erected, in his view, under the eye of Melchisedech, and its interpretation heralded the beginning of the millennium in 1882.

ACROSS THE DOWNS.

By Grenville A. J. Cole, M.R.I.A., F.G.S., Professor of Geology in the Royal College of Science for Ireland.

From Dorchester to Norwich, from Flamborough Head to Beachy Head, we all know the broad chalk uplands, broken at one point by the composite valley of the Wash, at another by the clays and sands of London, and again by the wooded excavation of the Weald. There are no peaks, and few decided summits, on these plateaux; from the long back of the Cotteswolds, we see in the south-east the next great step of England facing us, its top almost level, and sending out spurs into the richer country at its feet. The scarp rises smoothly, covered with short grass; the cloud-shadows sweep across it, unbroken and well outlined, forming almost a picture of the sky; and here and there a clump of beech-trees, or a circular British camp, forms the only feature on the crest. At morning or evening, however, the level sunlight picks out the coombes on the escarpment, great rounded hollows, in which trees may cluster along some ancient watercourse. Elsewhere, it is a dry country, and most of the streams that carved out the coombes have long since vanished into the earth.

This typical scarp can be seen on the way from

Cirencester to Marlborough, or between Oxford and Henley, or, again, between Aylesbury and Amersham; it is formed by the upturned edge of the Upper Cretaceous series—a series which has been swept off from the surface of central England and which here finds its present boundary. The plateau, when we climb to it, falls gently towards London, and streams have cut valleys in it, running south or east to join the Thames. This drop in the country corresponds to the dipping surface of the strata, and the next scarp is produced by the Eocene edge above them.

On the Cretaceous escarpment, the white quarries in the Chalk are everywhere in evidence. Here and there, pagan tribes and Christian imitators have scraped out great white horses on the slopes, which are visible, as geological signals, fifteen or twenty miles away. Sheep are pastured on the plateau, which is set with the little huts of their guardians, quaint affairs on wheels, resembling bathing-machines escaped. At times, a wood of beech and ash has been spared, and the road goes straightway through it, much as it did in prehistoric times. In the barer landscapes, where the forests were devastated, in all probability, by Britons and Romans for their camp-fires, we may see the tumuli, the graves of ancient days, forming grass-covered hillocks, ten, twelve, or twenty of them at a time, set upon the wind-swept sky-line. Even where the plough has made a brown patch in this open country, a gentle swelling in the field, seen when the sun is low, often reveals one of these "barrows," which are doomed to disappear amid the farmland.

In this bleak country stands Stonehenge, the one superb landmark on the way from Andover to Wells; away in the north is Avebury, at the forking of the three Bath roads, its huge monoliths rising among the gardens of a little village. Both these monuments, mainly formed of sandstone blocks, bear witness to the Cainozoic strata that once covered all the English Downs. Close to Marlborough, such masses still lie tumbled in the hollows, like the talus of a mountain-side; but in most cases they have been broken up, during centuries, as the only stone for walls or buildings. Formerly, sands must have spread across the country, as they still do in the Bagshot area; and the residual blocks, known locally as "sarcens," represent those parts of the beds that became cemented together and escaped decay. The "sarcens" are thus as much geological outliers, cut off from the London basin, as are the cappings of clay and conglomerate that we find left stranded on the edges of the Surrey Downs.

When man took possession of this rolling plateau, which is typified in Salisbury Plain or Marlborough Down, every village required its defence, each cluster of huts became a fortified encampment. The finest enclosure of the kind is seen in Old Sarum, which remained the official centre of the district down to Norman days. Even as late as the thirteenth century, the cathedral stood here within ancient British walls. This spot becomes of special interest to us, when we compare it with the cities, ringed about to this day, that we shall see when we go eastward and invade the plains of Picardy. The Romans, the Saxons, and the Danes, have ranged over our plateau of the Chalk, just as the English, the Spaniards, and the Germans, have made their pastime in the unfenced fields of northern France.

The Chiltern Hills lie on the south-east side of a great Cretaceous arch, formed by the broad folding of the strata that went on through Cainozoic times. We are unaware how far the Chalk spread westward; the clear deep sea, unburdened by detritus, in which this white limestone was laid down, may have lapped round the island-mass of Wales, and crossed by way of Cheshire into Ireland. It is certain that it spread, across a pebbly shore, over all the east of Ulster, and found its north-western boundary in the stubborn hills of Donegal. The chalk cliffs of the county of Antrim, gleaming from beneath their protective covering of basalt, may form, perhaps, the far side of the Chiltern arch, the whole intervening mass having been swept away from the crown of an enormous anticlinal.

The same gentle type of folding brings the Chalk down under London, and up again to form the North Downs of Kent and Surrey. The arch which follows this downward curve has been breached by the rivers that flowed over it, some going northward to the London Basin, some southward to the English Channel; and the clays and sands exposed by its removal give us respectively the oak-woods and the fir-clad ridges of the Weald. The South Downs, formed by another typical Chalk scarp, thus face the North Downs across a gap of thirty miles; but the two ranges merge on the west side, and we find the arch unbroken when we trace it to the heights of Selborne. Thence its crown spreads westward, forming a plateau country, until it dies out in the bleak upland north of Salisbury.

The east and west trend of the Wealden arch is no doubt connected with the pre-existing buried ridge, which is known to us by borings, and which runs beneath the London Basin. The Cretaceous rocks were pressed against this obstacle when the broad Cainozoic folds were formed; and their general north-east and south-west trend became here locally disturbed. When we cross the Channel to the white Chalk cliffs of Normandy, we find our Downs again, this time sloping south-eastward towards the Paris Basin.

There is little wonder that the Norman adventurers, and successive English kings, felt themselves so much at home on either side of the Channel. The woods on the French side are, perhaps, a little more frequent along the hollows; but the crisp short grass upon the slopes above, the white quarries, and the crops that struggle with a stony soil, recall at every point the familiar Chalk of England. The rivers, as with us have cut long valleys, out of which the roads climb steeply; and the heights along the Seine near Rouen may well remind us of the best part of the Thames at Henley. The open plateaux contain, as in our country, primitive little hamlets, often set back from the main routes, among their own trees, and clustered round a village green; the towns lie below, along the Somme, the Oise, the Aisne, and a hundred smaller streams. The forests have been more carefully preserved than in England, and cover large areas of the uplands. One may ride for miles along the straight level roads, through dark woods, in which the deer move softly; and here and there we emerge on some huge chateau, which, thanks to Viollet-le-Duc, takes our thoughts right back to Froissart, or the dim knight-errantry beyond.

On the north, the country is open to Flanders, and repeats all the features of the Netherlands. Windmills, canals, boats that appear to sail across the meadows, barns that assert themselves as the prominent features of the landscape, show how the Chalk has here dropped to the level of the sea. The old brick houses have a Flemish air, and the double names above the village-shops are certainly neither French nor Norman. The hamlets of Zutkerque and Volkerinckhove fail to conceal their origin; Moringhem, Ruminghem, and Salperwick, alike connect us with the north. As for the latter name, it carries us away to our own east-country fenland, where our Chalk also dips beneath the river-alluvium and the marshes, amid English windmills, wherries, and canals. In this open country, as we have hinted, each city is still a fortress; we enter by narrow and often winding roadways, between loopholes and the mouths of cannon; and the tall churches, crowning St. Omer, Laon, or St. Quentin, have looked down upon sieges, and have outfaced many a civil war. The Chalk has much to answer for, in favouring the spread of armies, and in raising no barriers to invasion. The fords in the deep valleys have proved difficult to strangers in the past; but Crecy-en-Ponthieu and Azincourt, to name no others, record the failure to dislodge an enemy from the plateaux.

The broad basin in which Paris lies was formed by folding, at about the same period as our smaller basin around London; its eastern rim, corresponding to our Chilterns, away beyond the vineyards of Champagne, similarly looks out on the back of the French Cotteswolds, that is, on the Jurassic range that runs from Dijon, by Langres and Nancy, into Luxemburg. Beyond this Jurassic scarp, the Moselle, running northward, plays the part of the English Severn. From Gloucester to Dijon, we may, then, broadly picture one great synclinal curve, formed of the beds of the Cotteswolds, which rise again and terminate as the bold Cote-d'Or in France; these bear on their backs the wide Chalk Downs, the Vespasian's Camp at Amesbury to Chalons-sur-Marne, the exercising fields of two lost empires; and these Downs wrap round and enclose in their turn the still later beds of London and of Paris. We have sought the Chalk again in Antrim on the north-west side of this enormous basin; where shall we recover it on the south-east, across the Moselle or the Rhone?

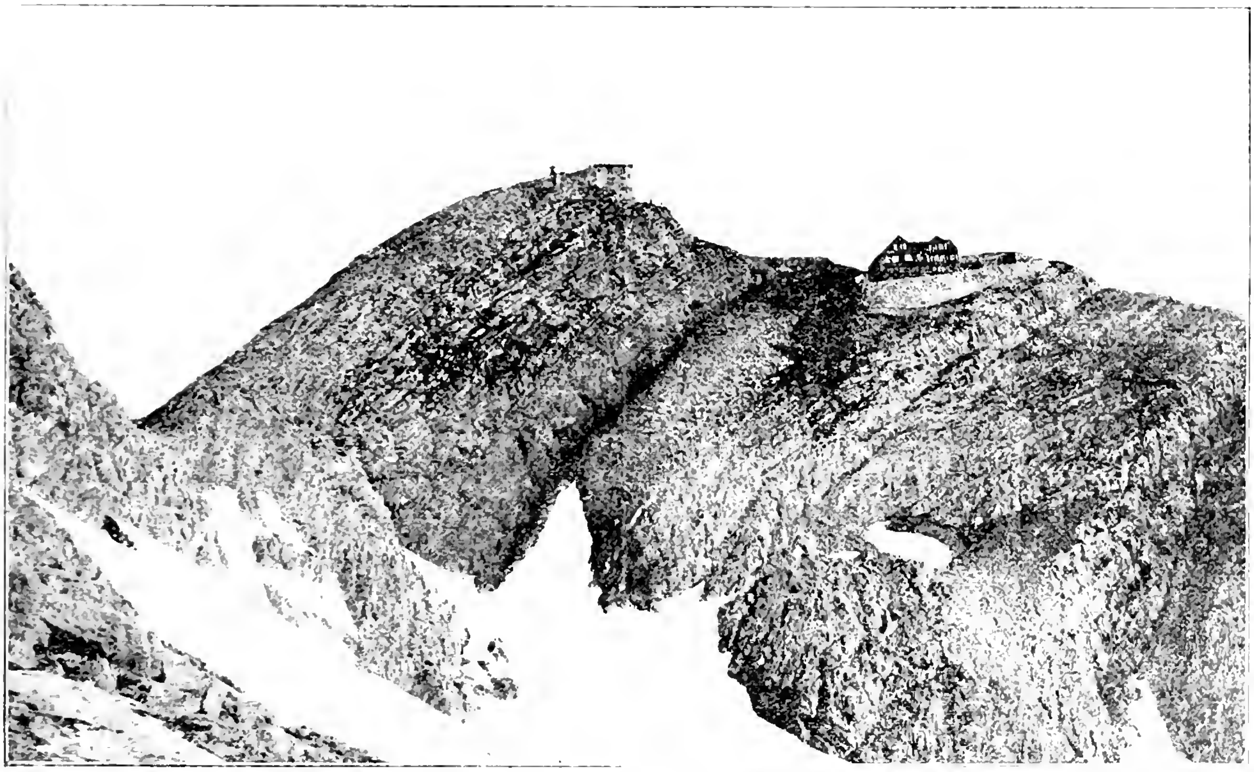


Fig. 1.—Summit of the Säntis, Switzerland, formed of Upper Cretaceous strata, with the dip-slope determining the mountain-side upon the left, and the escarpment forming the more craggy slope upon the right.

The folding that has had such mild effects in most of the Anglo-Norman area shows here and there far more serious results. West of Guildford, the Chalk dips at 35°; and in Dorsetshire and the Isle of Wight its beds are in places contorted or even vertical. Similar contortions are well known near Flamborough Head; but we now proceed to a district where earth-wrinkling has actually destroyed our Downs, and has left us only local Cretaceous strips, caught in the synclinal folds. The anticlinals, following closely on one another, consist of Jurassic rocks; the escarpments of the Cotteswolds and the Cote-d'Or are repeated again and again in the course of a few miles; and the dip-slopes are often as steep as the scarps, which are formed by the upturned limestone edges. This region of repeated folding gives us the beautiful parallel ranges of the Juras. Among the beds involved are some that correspond to our "Lower Greensand" strata, which come out around the English Weald; but in Upper Cretaceous times the Jura ridge had probably already risen, forming a chain of islands in the sea.

The Alps themselves, however, lay long beneath the ocean. The limestones that represent our Chalk were laid down in a clear sea that stretched unbroken into Syria; and on them the Eocene sea continued to deposit nummulitic limestone, rich in foraminifera and other marine types of life. When the great Alpine movements came, which were already foreshadowed in the Juras, the whole Cretaceous series became crumpled together like a cloth. In successive periods, the central Alpine mass moved upwards, culminating at the close of Miocene times; and denudation swept the Cretaceous and Jurassic limestones from it, leaving their contorted remnants in the foothills. Here they form superb scenery of slope and scarp, the higher strata, towering above the forests, being often belted with snow. The Chalk, which is so soft and white in the English plateaux, is here represented by a compact and brittle rock, as grey and firm as our old Carboniferous Limestone. In fold on fold it now comes out at the base of some inverted series, or now climbs five thousand feet, and caps a line of glorious crags. The capacity of these later geological deposits for forming mountains, when sufficiently hard pressed, is nowhere better seen than in the eastern Alps of Switzerland. The crest of the Säntis, for example, in Appenzell, 2504 metres (8213 feet) above the sea, is formed by an overfolded mass of "Seewerkalk," Gault, and "Schrattenkalk." Half of the topmost anticlinal is seen in our picture (Fig. 1), with the observatory and hotel upon it. Translated into our English equivalents, the highest crag represents the escarpment of the Surrey Downs; the dark and narrow band, starting from the left of the hotel, is the Gault, sand and clay, known to us in the level land, set with brickyards, at the foot of our soft green hills; and the mass below represents our "Lower Greensand," which is familiar in the Leith Hill range. The Eocene beds, corresponding to those of the London Basin, are squeezed in and folded under the Cretaceous masses on the north, far away below the crags of the Ebenalp and Oehrli; while we may see a representative of the Paris Basin in the synclinal on the south at Wildhaus.

The Eocene masses form hummocky knolls, as large as British mountains; the Greensand and Chalk are uplifted and glorified as veritable mountain-peaks. On the Titlis, nearer to the St. Gotthard, the Eocene itself can be seen infolded, at about 10,000 feet above the sea.

South of the Eocene basin of Wildhaus, the Cretaceous beds again arise, in the superb line of crags that look down into the Lake of Wallen. The crests of the Churfirsten are often capped by "Seewerkalk," and the whole Cretaceous and half the Jurassic systems appear here on one huge rock-wall.

The bold Alpine movements have, however, raised these strata to a dangerous eminence. Contorted as they are, the materials of the foothills are always in a state of strain. The beds are ready to snap asunder at the shock of earthquakes, or to slide on one another at any disturbance of equilibrium, such as may be caused by ordinary denudation. The disastrous landslip of Elm, in 1881, occurred among Eocene strata; that of the Rossberg, above Goldau, in beds comparable to those of Totlands Bay in the Isle of Wight; while the Diablerets, above the Rhone valley, form a noted spot for rock-falls, which come down from an upper Cretaceous scarp 10,000 feet above the sea.*

It is interesting to compare these destructive episodes with the slides of Chalk that occur from time to time at Dover, or along the Dorset coast. The earth-movements that raised the Alps folded and fractured England.† Lower Pliocene strata, with marine fossils, are known on the edge of the escarpment of the Kentish Chalk, and assign a modern date to the anticlinal and also to the excavation of the Weald. As we look across France to the notched anticlinals of the Alpine foothills, and to the marine Pliocene beds uplifted on their backs in Italy, the analogy of structure in the two areas becomes close indeed. The movements date in both cases from the same period of unrest; but their ultimate intensity has been vastly different. The broad curves of the French and English Chalk represent the far-reaching waves of an earth-storm that was gathering and breaking in the south. That storm spent its force in the great lines of elevation from the Pyrenees to the frontier of Tibet; but its after-tremors may occasionally reach us, and subsidiary folds may be still forming beneath our placid English Downs.

* Cole, Grenville A. J., "Open-Air Studies" (1895), p. 72.

† See particularly A. Strahan, "On Overthrusts of Tertiary Date in Dorset," *Quart. Journ. Geol. Soc.*, Vol. LI. (1895), p. 549.

THE MUD-NEST BUILDING BIRDS OF AUSTRALIA.

By D. Le Souef, c.m.z.s.

In Australia there are three genera of birds, not including swallows, which build mud nests, and strange to say these three genera contain but a single species each, and it is difficult to know in what group to place them. They are Corcorax melanorhamphus, Struthidea cinerea, and Grallina picata. All these, and especially the two first named, as will be explained below, are very sociable birds.

Corcorax melanorhamphus: "White-winged Chough."

This bird has been given the vernacular name of "Chough," because, although not strictly a Chough, it is most nearly allied to that species. It is popularly called the Black Magpie, but popular names, as is well known, are often far from correct. The bird inhabits open forest country, and, except in the extreme north and north-west, is found all over Australia, being in many localities plentiful.

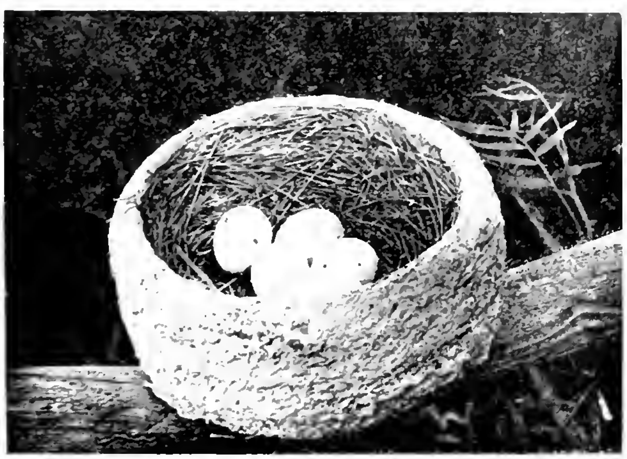
The general colour of the bird is black, but the inner web of each primary is white for a short distance from its base; this white marking is only seen when the bird is flying, but it is then very conspicuous. Curiously enough there frequently seems to be a festering sore place on the skin at the base of the bill, and the birds themselves often have an unpleasant odour. Their food consists of insects, and the birds generally feed on the ground. When disturbed they

Nest of *Corcorax melanorhamphus*.

fly into the lower branches of a tree, and, hopping and flitting from one branch to another, soon reach the top, and fly away. When one bird is shot at, and wounded so that it is prevented from escaping, its cries attract the rest of the flock to it, and, coming within gun shot, are easy victims to the sportsman. They always go in companies or flocks, which, during the nesting season, consist of from six to fifteen birds, but later on, when the young birds have left their nests the flocks often aggregate up to thirty or more. These birds are heavy flyers, but otherwise very active. During the nesting season, the male bird, when in the presence of the female, often goes through various antics, such as spreading out his wings and tail, in order to attract her attention. In the latter end of August or early in September they commence building, several of the birds helping to construct the same nest. Three are generally built by one company during the season, a new one being started as soon as the eggs in the previously made nest are hatched out. From what I have observed, I consider that several hen birds lay in the same nest, the number of eggs varying from four to eight. Should one sitting bird be shot, another will take her place, and I have known three birds to have been shot from one nest, after which they were left in peace to their family cares. When the young are hatched, several birds feed them, and consequently they grow fast. The nest, which is the common property of the flock, is a bulky, open structure made of mud and weighing sometimes as much as nine pounds. It is lined with either dry grass, fur, or shreds of bark from the Eucalyptus trees, and is generally placed on a dry horizontal branch at a considerable distance from the ground. As the branch chosen is often small compared with the nest itself, the birds build the sides of the nest down below the branch, and thus their home is balanced and held on more securely. The diameter of the interior of the structure is six inches and the depth three inches. The eggs are white, with bold irregular dark brown markings, and average dimensions of 1.52 by 1.12 inches.

Struthidea cinerea: "Grey Jumper."

These interesting birds are very similar in their habits to the Corcorax, and are often found in their company. They also live in flocks of from five to fifteen birds, and in consequence are called in some



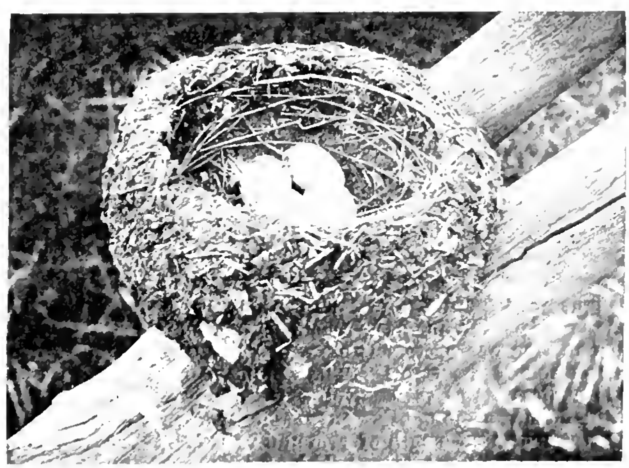
Nest of *Struthidea cinerea*.

districts the "Twelve Apostles." They are not found in the extreme north of Australia, nor yet on the north-west side, but are everywhere else. Active birds, of prevailing grey colour, they have a harsh note, and are noisy. They generally secure their insect prey on trees and are only occasionally seen on the ground. Like the Corcorax, their nest is common, and several birds help in building it. Three nests are usually built during the season, and a fresh one is commenced when the young birds in the first are about a week old. From four to eight eggs are laid, evidently by several hen birds, as in a nest. Mr. H. Lau found, belonging to a flock of twelve birds, eight eggs were laid in six days. The mud nest, shaped like a basin, is neatly built and generally perfectly spherical. It is well lined with long pieces of dry grass, the interior diameter measuring four inches and the depth two inches, and is supported on a horizontal bough, occasionally low down, but generally from nine to fifteen feet from the ground. The eggs are white with a few blackish streaks, generally on the larger end. On some eggs the markings are altogether absent.

Grallina picata: "Magpie Lark."

This beautiful and graceful bird is found in every part of Australia where there is water. Often to be seen about country homesteads, it is a great favourite, strictly insectivorous, and very tame.

It has various local names—Peewit, from the double note the bird utters, being the most common. During the nesting season the birds are generally seen in pairs, but in the winter months they often congregate together in considerable flocks, which are composed chiefly, I think, of young birds, as the old pairs seldom seem to stray far from their favourite locality, and generally nest year after year either in the same tree or not far from it. Their old nests are frequently used by other birds, such as the Wood Swallows (Artamus), and Frogmouths (Podargus), which build their own homes in them. Many birds, especially hawks, prefer using old nests of other birds, which they trim up to suit their own requirements, instead of building fresh ones for themselves. The Grallina invariably feed on the ground and generally in moist situations. The inside of their open mud nest measures four and a half inches in diameter by three and a half inches in depth. It is



Nest of *Grallina picata*.

lined with dry grass, although occasionally bark or feathers are used. Both birds help in its building, and, after finishing, they leave it for about a fortnight to dry before occupation. Some tree in the vicinity of water is always chosen as a site for the nest, and often the Black and White Fantail (Rhipidura tricolor) builds its cobweb-covered nest close to that of the larger bird, and joins with its neighbour in driving away hawks and other common enemies. Many birds like to build in company, as I have frequently noticed when travelling in the country. Even the little Acanthiza chrysorrhoa makes its nest among the sticks which form the foundation of the Eagle's home (Aquila audax). Five eggs form a full clutch, and they vary much in colour and disposition of markings, some having a white ground and others a reddish pink. Again, in some eggs the reddish-brown markings form an irregular zone round the larger end, while in others they are scattered all over the egg. Some eggs are elongated in shape, others much more rounded, and their average measurements are 1.18 by .82 inch.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

"Microscopy and Micro-technique," by Dr. Albert Schneider, of the North-western University, is another work which we can confidently recommend to our readers. The self-explanatory title enables us to dispense with a description of its aims. It embodies many facts and suggestions resulting from long observation and a very varied practical experience; and it is specially suitable as a work of reference for all who are interested in biological research.

Mr. C. A. Kofaid, of the Illinois Biological Station, has devoted, during recent years, considerable attention to the biology of the plankton; and his investigations have shown that the Henson method of collecting with a silk net, as usually practised, is very faulty and likely to lead to erroneous conclusions. The leakage of the planktonts through the yielding meshes of the silk, caused by their struggles and the pressure of the filtering water, is so considerable as to give rise to grave errors in the final computations. A considerable volume of the plankton is lost at all seasons of the year, and in some instances the actual catch of the silk net is but a small fraction of the total present. The plankton thus lost is composed very largely of minute algæ, which constitute a fundamental link in the cycle of aquatic life.' To prevent these losses he now employs a filter made of filter paper No. 575, Schleicher and Schüll. It is very free from lint, and does not easily tear when wet. As the filtering proceeds, the plankton is condensed in the bottom of the funnel by means of a fine spray from a hand bulb. The method is very simple and rapid, and it yields from 75 per cent. to 80 per cent. of the planktonts, as compared with 45 per cent. to 50 per cent. with the silk net. The Henson method answers well enough for the larger forms, such as the *Entomostraca* and the larger *Rotifera* and *Protozoa*, but it is quite inadequate for the retention of *Melosira*, *Peridinium*, *Dinobryum*, *Raphidium*, *Englena*, and other of the smaller and frequently very abundant planktonts.

At a recent meeting of the Royal Microscopical Society, Dr. Measures exhibited an instrument for micrography made by Zeiss, having a new form of fine adjustment, which admitted of the arm being made of any length without throwing any weight upon the fine adjustment screw. The manner in which the speed of the fine adjustment is reduced is most ingenious. The motion was extremely slow, being only 1·625 in. for every revolution of the screw. The application of the principle of the endless screw is a novel way of slowing down the fine adjustment. Among other advantages claimed for the apparatus are the increased length of arm and the reduction of weight on the fine adjustment to one-fifth of that which is usually put upon it.

For histological and biological work, an Abbé sub-stage condenser is indispensable. With the condenser open a cone of light, having an angle of divergence of 120°, is brought to a focus upon the object. Viewed with this intense light, the delicate contours of transparent objects, which are made visible by differences of refraction, are almost entirely lost, and the stained portions of the specimens which would be, without the condenser, more or less concealed by the outlines of the unstained portions, stand out in bold relief. This "isolation of the stained image," as Koch terms it, is of great value in histological study. An Abbé condenser should be found in every histologist's laboratory.

Ground glass is a useful adjunct to the laboratory appliances of microscopist and microphotographer; but it is not always possible to obtain glass having a grain of sufficient fineness to be of much use. Ground glass may be easily prepared by placing some fine emery powder between two pieces of glass, and then rubbing the glasses together for a few minutes. If the glass becomes too opaque it may be rendered more translucent by rubbing some oil upon it.

One of the principal reasons for using lacquer on microscopes is to protect the metal from oxidation. Lacquer is readily soluble in alcohol, and great care should therefore be taken when using this reagent. The practice of cleaning the brass work of the instrument with alcohol is, therefore, to be deprecated.

NOTES ON COMETS AND METEORS.

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

Giacobini's Comet (1900 a).—The discoverer gives parabolic elements in Ast. Nach. 3624, from observations on January 31st, February 3rd and 6th. The comet is now practically invisible, being extremely faint and situated too near to the sun for satisfactory observation. Its perihelion passage will take place on April 28th, but there is scarcely a possibility that the object will be observable at this period even in very powerful telescopes. On February 21st the comet was observed by Kobold at Strassburg, and he describes it as 1 minute of arc in diameter, round, and between the 12th and 13th mag.

In April the relative motions of the comet and earth will cause the two bodies to begin to approach each other, and in May and June this approach will be very rapid, so that in July and August the comet will be much nearer the earth, and considerably brighter than it was at the time of its discovery. It will also be very favourably visible as regards its position in the sky. The following condensed ephemeris by A. Berberich (Ast. Nach. 3627) will exhibit the varying position and distance of the comet during the ensuing six months:—

Date 1900		R.A. H. M.	Dec. ° ′		Distance from Earth in Millions of Miles.
April 3	...	1 44·4	+ 11 27	...	217
„ 27	...	1 33·2	+ 17 28	...	214
May 29	...	1 9·0	+ 27 7	...	180
June 30	...	23 46·9	+ 41 31	...	128
Aug. 1	...	19 36·3	+ 41 20	...	111
Sept. 2	...	17 39·2	+ 17 50	...	170
Oct. 4	...	17 23·2	+ 5 55	...	251

Large Comets.—It is now many years since we were visited by a really large comet favourably visible in the evening sky. In June and July, 1881, a fine comet presented itself in the northern heavens, and in August of the same year Schaeberle's comet became fairly conspicuous as it passed under the well-known stars of Ursa Major. A brilliant comet with a tail 22 degrees long was perceptible in the autumn mornings of 1882. Since that year we have had several fairly conspicuous comets, but not one with a position and brightness which enabled it to arrest much public attention. It is a curious fact, to which the writer drew notice in the "Astronomical Register" for April, 1883, that the majority of the large comets of the present century have appeared at intervals of about 19½ years. There were several large comets observed in or near the years 1823, 1843, 1862, and 1881. If this cycle indicates something more than fortuitous agreements then we may expect to see several fine naked eye comets during the ensuing few years. This should be an encouragement to comet-seekers to redouble their efforts. But though the cycle referred to appears to be tolerably well marked it is difficult to understand how it could exist in relation to bodies having exceedingly long periods, and, moreover, it apparently fails in its application to the large comets of the 18th century.

Doubly Observed Meteors.—On January 25th, 11h. 10m., a meteor of about 2nd mag. was recorded by Prof. A. S. Herschel at Slough, and Mr. J. H. Bridger at Farnborough. The radiant was at 45 degrees plus 62 degrees, and the meteor descended from 65 to 44 miles over Warwickshire. On January 27th, 11h. 10m., a very slow-moving meteor of 1st mag. was registered by Prof. Herschel at Slough, and Mr. A. King at Leicester. Its radiant was at 5 degrees minus 16 degrees, and it fell from [illegible] to [illegible] miles, ending almost vertically over Leicester. These doubly observed meteors are valuable as affording distinct evidence of feeble radiant points which have not been previously observed at the same period of the year. Hence there is great utility in maintaining simultaneous watches, for a pair of accurate observations of a meteor will enable the radiant point of a scanty shower to be exactly determined though such a shower may be too feeble to be ever recognised by isolated observation.

Large Meteors.—On November 27th, 9h. 20m., a remarkable bolide was seen by Mr. C. N. Neuott at Sotia. It travelled from the square of Pegasus towards Capella, and broke into two parts. On February 11th, 8h. 19m., Mr. A. C. Panfield, of Tenbury, observed a meteor brighter than Sirius. It passed from Eridanus to 20 degrees S.E. from Sirius, and was visible for about 15 seconds.

Stationary Radiants.—In Ast. Nach. 3625, M. Bredikhine gives the orbits of a number of showers composing the long enduring radiants near Beta Persei and Zeta Draconis. The differences in the elements induces him to believe that stationary radiation is brought about by a series of distinct streams supplementing each other from the same apparent directions. This explanation has been previously offered but it is quite inadequate to satisfy the observations. The accidental grouping of radiants would not enable them to cluster at certain centres to the exclusion of surrounding spaces. A number of different showers succeeding each other from the vicinity of a fixed star would give radiants round about the star, being sometimes E., W., N. and S. of it, but a stationary radiant retains a constant position relatively to that of the star near which it may be placed. This fact is of great significance, and negatives the idea that mere chance grouping is responsible for the production of stationary radiants.

April Lyrids.—The moon will be full on April 15th this year, so that the shower can be best observed in its later stages. As 1900 is not a leap year the maximum will probably occur on April 21st, when the moon rises at 13h. 23m. But in 1884 the writer observed a very active return of the shower on April 19th, 11h. to 12h. It seems necessary therefore to maintain a watch both on the nights of April 20th and 21st before moonrise. The shower is visible for about a week, April 17-24, and its radiant is a moving one like that of the August Perseids, but the Lyrids are usually so rare that this feature in regard to them has never been sufficiently investigated. Observers should carefully ascertain the position of the radiant on successive nights, and in this connection the meteors moving in declination will be very valuable as serving to indicate the R.A. accurately.

THE FACE OF THE SKY FOR APRIL.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 5.37 and sets at 6.31; on the 30th he rises at 4.36 and sets at 7.18. Occasional small spots may occur, but large outbursts are not to be expected. The sun is at its mean distance from the earth on the 1st.

The Moon.—The moon will enter first quarter on the 6th at 8.55 p.m.; will be full on the 15th at 1.2 a.m.; will enter last quarter on the 22nd at 2.33 p.m.; and will be new on the 29th at 5.23 a.m.

The following are the most notable occultations visible at Greenwich:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Apr. 3	B.A.C. 1373	5·7	8.47 p.m.	88	47	9.44 p.m.	275	245	4 0
,, 4	o Tauri	4·8	9.30 p.m.	71	29	10.22 p.m.	304	263	5 1
,, 8	α Cancri	4·3	11.46 p.m.	91	53	12.45	317	277	9 3
,, 21	ξ² Sagittarii	3·5	2.27 a.m.	87	110	3.42 a.m.	275	267	21 6
,, 24	[illegible] Capricorni	5·2	3.23 a.m.	11	45	3.57 a.m.	306	337	24 7
,, 24	[illegible] ,,	6·2	3.34 a.m.	83	116	4.37 a.m.	233	260	24 7

The Planets.—Mercury is the morning star throughout the month, but though he reaches an elongation of over 27° on the 24th, he is badly placed for observation in our latitude. Only in the tropics and in the southern hemisphere do western elongations in our Spring provide favourable opportunities for the observation of this planet.

Venus will be a very brilliant object throughout the month. On the 28th, at midnight, she will be at greatest eastern elongation, 45° 30′. During the month she travels from near the western boundary of Taurus to near the eastern limit of that constellation; on the 8th and 9th the planet will be nearly midway between the Pleiades and Aldebaran, and on the 28th between Zeta Tauri and Beta Tauri. The apparent diameter increases from 18″ on the 1st to 24″ on the 30th. At the middle of the month a little less than six-tenths of the disc will be illuminated.

Mars is a morning star, rising about 4.45 a.m. at the middle of the month, but with his apparent diameter of 4″·2 is of little interest to observers. During the month he describes a long direct path through the lower part of Pisces.

Jupiter rises just before midnight at the beginning of the month, and a little before 10 p.m. at the end. During the month the apparent diameter increases from 38″·0 to 41″·0. The planet has a slow westerly motion in the south-western part of Ophiuchus, about 5° north-east of Antares.

Saturn rises about 1.45 a.m. at the beginning of the month, and about 11.45 p.m. towards the end. His path is very short, but 2 degrees north of Lambda Sagittarii. The planet is stationary on the 14th.

Uranus traverses a short retrograde path in the south-western part of Ophiuchus. At the middle of the month the planet will be nearly 2 degrees east and 1 degree south of Jupiter, lying nearly midway between Antares and Eta Ophiuchi throughout the month.

Neptune sets about 1 a.m. at the beginning and about 11 p.m. at the end of the month. His path is a short easterly one to the north-east of Zeta Tauri; the planet is 1 degree north of that star, 1m. 11s. following on the 1st, and 6m. 55s. following on the 30th.

The Stars.—About 9 p.m. at the middle of the month, Leo will be on the meridian, Gemini in the south-west, Orion in the west, Virgo in the south-east, Hercules in the north-east, and Ursa Major almost overhead.

Algol may be conveniently observed at minimum on the 20th at 9.45 p.m.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solution of March Problem.

(J. K. Macmeikan.)

Key-move.—1. B to R5.

If 1. . . K to K4, 2. R to B5, etc.
1. . . K to Kt5, 2. Q to KRsq.

Correct Solution received from [illegible] Baddeley, Capt. Forde, H. S. Brandreth, W. N. [illegible], J. W. Meyjes, Alpha, W. de P. Crousaz, K. W.

K. W.—The majority of the Knowledge corps of solvers will not try mi-mates. One or two short ones will be inserted from time to time, in notation, as you suggest.

J. W. Meyjes.—Your solutions to last month's problems did not arrive till after this page had gone to press; otherwise you would have been credited with No. 1, in spite of the clerical error.

G. B. Gooding. P to Q4 is a near try, but Black can reply 1. . . . P × P en passant. Moreover after 1. . . . K to Kt6, 2. Q to Q2, K to R6; 3. Kt to B5 is not mate, as the Black Pawn can cover the check.

W. Parkinson. See reply to G. B. Gooding above.

J. T. Blakemore.—Correct solutions to J. G. Campbell's problems just too late to acknowledge last month.

Problems received with thanks from W. H. Gundry, N. M. Gibbins, W. Clugston. They will appear shortly if found to be correct.

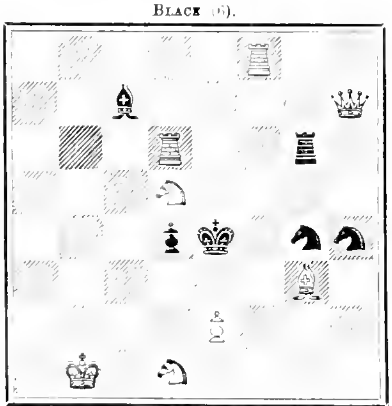
It is interesting to learn that the four-move problem which appeared in the October Number obtained first prize, out of 52 entries, in the problem tourney of the "British Chess Magazine." The composer was Karel Traxler, of Bohemia. Below are two of the prize-winners in the recent problem tourney of the "Birmingham Daily Post." Some judges might consider them superior to the first and third prize winners.

No. 1.

Second Prize.

By W. Gleave (London).

Black (6).



White (8).

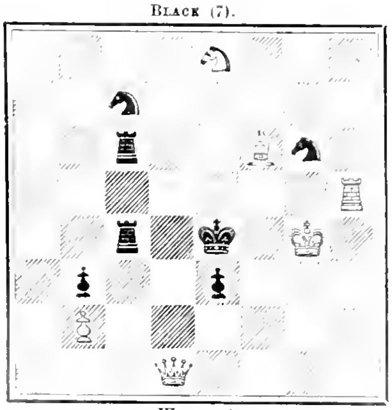
White mates in two moves.

No. 2.

Fourth Prize.

By Henry A. Wood (Shaw).

Black (7).



White (6).

White mates in two moves.

CHESS INTELLIGENCE.

The English side for the forthcoming cable match with America will consist of Messrs. H. E. Atkins, G. E. Bellingham, J. H. Blackburne, E. M. Jackson, Herbert Jacobs, T. F. Lawrence, F. J. Lee, D. J. Mills, H. W. Trenchard, and W. Ward. The reserves will be Mr. E. O. Jones, Mr. Physick, and Mr. Passmore. The match takes place on March 23rd and 24th at the Monaco Restaurant.

The annual Hastings and St. Leonards Chess Festival is fixed for March 30th to April 3rd inclusive. Messrs. Blackburne, Mason and Teichmann are the masters engaged. There will be the usual consultation games, and blindfold and simultaneous exhibitions, as well as some local events, including a match between teams of 100 players representing Kent and Sussex.

The City of London Chess Club has organised an Invitation Tournament, in which seven professionals and seven amateurs are to compete. The seven prizes to be given amount to £64. Play begins at 7, Grocers' Hall Court, Poultry, on April 5th, with an adjournment between April 12th and April 18th. The tournament will be an interesting test of the relative strengths of British amateurs and professionals, and will give the latter an excellent opportunity of getting into practice for the Paris International Tourney.

Mr. Bellingham is playing a match with Mr. Burn; the present score is 4½ to 1½ in favour of the former and as the match is limited to nine games Mr. Burn cannot now win it. At Chicago Mr. Marshall, the winner of the minor tournament in London, has defeated Mr. S. P. Johnstone by the narrow majority of 7 games to 6. Both players took part in the cable match last year, and will probably play again. Mr. Delmar has won two short matches with Mr. Halpern and Major Hanham.

In the South-Eastern section of the S.C.Ch.U. tourney, Hampshire succeeded in defeating Sussex by 9 games to 7, the latter team being two men short. Hampshire accordingly tied with Surrey for the leadership of the section, but were defeated rather easily in playing off the tie. The final will lie between Surrey and either Somerset or Gloucestershire.

The "Richardson" cup competition for Scottish clubs, limited to teams of five, has at length been decided. In the final tie the Glasgow Club defeated Edinburgh by 3 games to 2.

For Contents of the Two last Numbers of "Knowledge," see Advertisement pages.

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OF
SCIENCE, LITERATURE & ART.

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OCEANIC NEGROES.

By R. Lydekker.

Like many other terms, the word Negro, and more especially its vulgar corruption "nigger," has a popular, and indeed an etymological, significance very different from the sense in which it is employed in anthropological science. Etymologically, of course, it means simply a black man, and is therefore legitimately applicable to all dark-skinned races, of whatever origin: although there is the difficulty of determining where to draw the line between dark and light-skinned races, since there is a complete transition from the one to the other. In this sense, therefore, the dark-skinned races of Somaliland and Nubia may be termed Negroes, although they have a large proportion of Arab blood in their veins. The wild tribes of India and Ceylon, forming the subject of another article in Knowledge, may likewise be so termed; and, however much they may dislike such an appellation, it is difficult to see how many of the higher races of India can claim an exemption from this use of the name.

But in a scientific sense the term has a much more limited application, although even here difficulties are met with in defining it when we have to deal with cross-bred races like those of North-eastern Africa. If the aborigines of Australia be excepted (and it has been shown in an earlier article that there are some reasons for regarding them as belonging to a different stock), a Negro may best be defined in popular science as a person with frizzly, or, incorrectly, woolly, black hair, and generally a very dark, or even black complexion. The hair is, however, a much better character than the colour of the skin, which in the South African Bushmen is of a leathery yellow. Accompanying this frizzly hair, we may generally notice in Negroes an elongated skull, a broad and flat nose, thick and projecting lips, relatively large teeth, and moderate or scanty development of the beard. Closer examination will reveal the fact that the fore-arm of a Negro is longer in proportion to the leg than is the case in an average European; and there is also less development of the calf of the leg, as well as a marked difference in the form of the heel. But to record all such minutiæ would be practically to write a treatise on anthropology; and I must accordingly ask my readers to be content with the frizzly hair as the essential characteristic of a pure-bred Negro.

Now we all know that such frizzly-haired black (occasionally yellow) skinned people populate the greater part of Africa, whence numbers of them have been transported in the old slaving days to various parts of America. And it is among these black African races that we have the typical Negro of anthropological science, and, probably, also of popular speech. But Negroes, even in the scientific sense, are by no means restricted to what, from an anthropological point of view, may still be aptly designated the "Dark Continent." Frizzly-haired black races are met with in the Andamans and Philippines, as well as in some of the neighbouring islands; but since all these people differ from African Negroes by their broader and shorter heads, they have been separated under the name of Negritoes; and it is not of these that I desire to treat on the present occasion. Further eastwards, in that part of Oceania now commonly designated (from the colour of its inhabitants) Melanesia, we find "mop-headed," frizzly-haired races, agreeing so essentially in physical characters with African Negroes, that there can be no reasonable doubt of their comparatively near relationship to the latter. As some of my readers may perhaps be a little hazy as to the precise signification of the term Melanesia,* it may be stated for their benefit that it includes the great island of New Guinea, or Papua, together with the Louisiades, the Bismark (New Ireland and New Britain) and Solomon groups, the New Hebrides, the Loyalty group, and New Caledonia. The mountains of the interior of Fiji are likewise inhabited by members of the same negro-like race.

In regard to a general name for these Oceanic Negroes, as they are perhaps best called, authorities are somewhat divided. By the Malays the aborigines of New Guinea are designated Orang Papua (pronounced Papooa), and some writers extend the term Papuans to embrace the inhabitants of the whole area. On the other hand, the term Melanesians, originally proposed

* In the "Times Atlas" the name Melanesia, although omitted from the index, occurs in the map of the world, but not in that of the Papuan Archipelago.

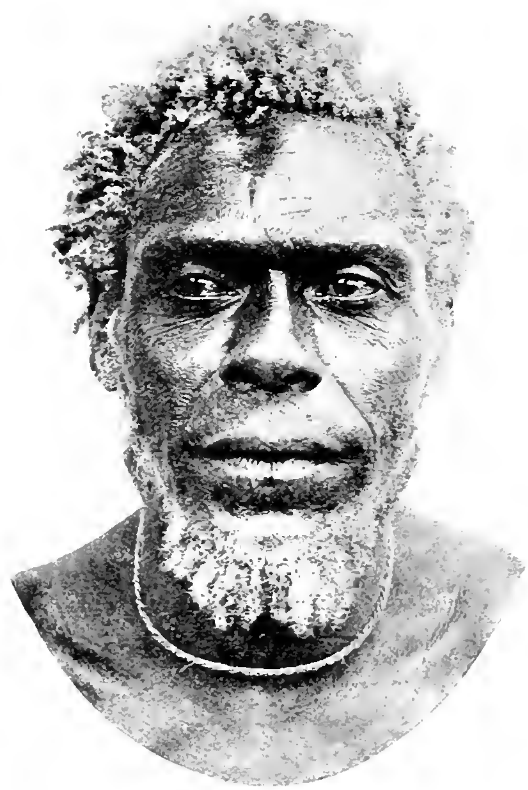
for the inhabitants of the islands other than New Guinea, has likewise been employed in the wider sense; and it is this usage, when a general term is required, that is followed here.

A typical Melanesian has the same dark skin as an African Negro, and likewise a similarly elongated skull, whereby he is separated widely from the round-headed Negritoes of the Andamans and Philippines. Indeed, the Kai Colo tribe, of the mountains of Fiji, have longer and narrower skulls than almost any other people. A Melanesian skull may be generally distinguished from that of an African Negro by the heavy ridges over the eyes; these brow-ridges being almost absent in true Negroes. As similar brow-ridges occur among some of the prehistoric natives of South America, an affinity has been suggested between these people and Melanesians, but on altogether insufficient grounds. The jaws in the Melanesian skull are projecting, and the cheek-bones very wide; and since the forehead generally narrows superiorly, while the chin is not very broad, the form of the face very frequently is that of a long oval, pointed above and below. The nose, especially in New Guinea and the adjacent islands, is narrower and more prominent than in African Negroes, and is never of the broad, saddle-shaped type so characteristic of Australians; it is, however, generally low and somewhat broad at the root, tending towards an aquiline type among some of the inhabitants of Yule Island. The mouth is broad and full, but the lips are by no means so protuberant as are those of the typical African Negro. The most striking common feature between Oceanic and African Negroes is the frizzly hair, which is quite different from the wavy locks of either the Australians or the Polynesians, and still more so from the long lank tresses of the Malays. There is, however, a certain difference between the hair of Melanesians and Africans, the former growing in very marked and regular waves, and thus being more like wool than is the latter, which forms an uneven tangled mass. His hair is indeed the strong point of a Papuan, and it is often dressed and frizzed till it stands out in a mop-like manner on all sides. Feathers and the tails of kangaroos are employed for its decoration, and combs for its dressing. Only in cases of serious illness do the men cease to attend to their hair; but in the girls it is kept shorter, and in some tribes the married women cut it quite short or even shave it off. On the other hand, the men are careful to pluck out every hair from their beards, and sometimes extend the operation to their eyebrows. As regards their muscular development, Melanesians display a powerful build in the upper part of the body, the shoulders being broad and the arms strong; but there is a woeful falling off in the lower extremities, which, especially in the men, are long and thin, with very small calves.

Turning to the consideration of the affinities of the Melanesians, there seems every reason for regarding them as a pure-bred race, which has no intimate relationship with their near neighbours the Malays. The form of their heads likewise separates them from the Negritoes of the Andamans and Philippines. But in this latter respect, as well as in the character of the hair, they come so close to the African Negro, that there can be little hesitation in regarding both races as derived from a common ancestral stock, notwithstanding the birth-place of such stock cannot be determined. That the date of divergence of the two races must be very ancient, seems evident from the absence of any common feature in their language.

More difficult is the question of their relationship to the Australians. Tasmanians, and Polynesians. With regard to the former, as stated in a previous article, I am inclined to agree with Dr. Semon that they have no direct kinship. If this be so, the extinct Tasmanians can scarcely any longer be considered as pure but aberrant members of the Melanesian group; and we may perhaps regard them, with Dr. Semon, as having originated from a crossing between the inhabitants of Australia and immigrants cast by chance into those regions; such immigrants being presumably Melanesians.

As already mentioned, the mountains of the interior of Fiji are inhabited by frizzly-haired Melanesians, but the lowland population of that group of islands is formed by the wavy-haired people known as Polynesians. And these Polynesians extend over the whole area from which they take their name, being represented in New Zealand by the Maori. Now it is generally admitted that the Polynesians have a certain



amount of Melanesian blood in their veins; and it has been supposed that the whole of Oceania, from Flores eastwards, was originally populated by frizzly-haired Oceanic Negroes, whose descendants in Polynesia have been so profoundly modified by crossing with an immigrant type as to have formed practically a new race. If we ask who were the immigrants, the most probable answer is Malays. And that such a mixture would produce the Polynesians, as we now know them, was the opinion of the late Sir W. H. Flower. And in a modified degree this appears also to be the view of Dr. Semon, who, after stating that if Melanesians and Polynesians be more closely related than is commonly supposed, writes that this "would only show Polynesians to be a branch of the Papuan race, which, by admixture with other races, principally Malays, and by a subsequent independent development, has become developed into what may be termed a new type." It is added that, apart from a Polynesian immigration into South-eastern New Guinea (which does not affect the question), "a relation between Papuans and Polynesians cannot be absolutely denied." And some observers have even gone so far as to assert that, with the exception of the difference in the hair, there is very little physical distinction between typical Polynesians, such as the Samoans, and pure-bred Papuans.

On the other hand, it has long been noticed that many Polynesians, and more especially the Maori, exhibit a decidedly Caucasian type of feature, and hence it has been inferred that the immigrant stock which has produced the present race by fusion with the original Melanesian element was Caucasic rather than Malay (Mongolian). The fact that the Polynesians generally have straight black, rather than wavy hair, is one among several circumstances that makes me incline towards the Malayan theory.

But by this time my readers must be getting tired of discussions on phylogeny; and I must accordingly say something in regard to the character and status of the Oceanic Negroes. And here it is well to mention that Negroes of all descriptions stand on a much higher platform of intelligence than people like the Australians or Veddas; their faculties being indeed capable of a comparatively high degree of development, although their political organisation is at a low grade.

We are, it is true, accustomed to regard the Papuans as cruel and bloodthirsty savages, but this, according to Dr. Semon (from whose observations the greater part of the remainder of this article is compiled), is far from being a correct estimate of their general character. It is true that the Papuan is hideously cruel in warfare, subject to passionate outbursts of uncontrollable fury, unreliable in his dealings with the foreigners with whom he is brought in contact, and eager to possess himself of valuable or desirable property in the hands of strangers. But he is essentially a creature of impulse, and it is this impulsive nature which leads to his proneness to murder and rob his fellow man. His paroxysms of rage are, however, short-lived; and in his normal condition he is bright, gay, and harmless, displaying great kindness in the treatment of his wife and family, and mourning for his lost relations in a way that marks him as possessing humane feelings of great intensity. Living in a country and climate where he has but few wants except food, and much of the latter being procurable with comparatively little exertion, he is naturally not prone to hard work, leading a kind of lotus-eating existence, whose calmness is only disturbed by tribal wars, or by hostile outbreaks against the foreigner.

Having thus a large amount of time at his disposal, and being apparently inclined by nature towards the cult of the beautiful and the ornamental, the Papuan turns his attention towards the decoration of his home and domestic implements and utensils. His artistic efforts cannot be compared with those of civilized nations; still, the ingrained love of decoration and ornamentation seem to be more highly developed than in any of the latter. For, as Dr. Semon remarks, do we ever find the European boatman carving and decorating his oar, the carpenter his adze, or the husbandman his plough. And yet every Papuan implement and weapon (and they are too numerous to refer to in detail on this occasion) bears witness to the artistic power and patience of its owner; while not less noteworthy is the attention paid to the decoration of the person. However, Papuan and European ideas of what is becoming in the latter respect are by no means identical. As regards their fondness for personal adornment, both sexes of Papuans present a remarkable contrast to their Australian neighbours; while in respect to their weapons and implements there is, of course, no sort of comparison between the two races. Not the least noteworthy circumstance is the absence among the Papuans of the one really effectual Australian weapon the boomerang; this alone being almost sufficient to indicate that the two races have no close relationship.

The Papuans are to a great extent a coast-dwelling people, the greater part of the mountainous interior of their island, except on the lines of the great rivers, being uninhabited. The chief pursuits of the men are hunting and fishing, together with sailing; but they are in the habit of taking long voyages, when rough seas must at times be encountered, nevertheless their fishing is always conducted during fine weather. The women, on the other hand, undertake all the duties of the home and the plantation; those living in districts where the necessary material is obtainable, manufacturing pottery for household and other purposes. Liberty and individual freedom seem as essential to the Papuan as to the Briton; chiefs, of a kind, are recognised, but their sole duty is in connection with foreign affairs. This characteristic freedom is doubtless one cause of the objection of the Papuans to hard work, especially carrying burdens, for which they are indeed physically unfit, being absolutely incapable of bearing half the loads carried with ease by African Negroes.

Neither can the Papuan be credited with the attributes of a bold or fearless warrior; the natives of British South-east New Guinea are stated to be more courageous than those of the northern German and Dutch districts. Indeed, cases have been recorded of voluntary self-sacrifice on behalf of a comrade, yet Papuan warfare is generally characterised by treachery, and ruthless slaughter or torture of the members of other tribes taken by surprise, together with the massacre of defenceless women and children. Cannibalism is also a recognised practice.

Dr. Wallace regards the Papuans as intellectually equal, if not superior to their Malay neighbours, an opinion which is not shared by the majority of observers. Dr. Semon, for instance, considers their intellectual standard far above that of the Australians, but decidedly inferior to that of the African Negro, which, under the favourable circumstances existing in America, he is inclined to rank rather high. Compared with his Polynesian neighbours, the Papuan school-child is indeed stated to be decidedly inferior; and this mental inferiority apparently persists throughout life.

As regards marriage customs, the peculiar prohibitions of intermarriage between even distant relatives which forms such a characteristic feature of the Australian aborigines, are conspicuous by their absence among Papuans in common with Melanesians generally; and this, again, so far as it goes, serves to accentuate the great gap between the latter and Australians. Polygamy is the recognised custom throughout Melanesia; and, as is generally the case under such conditions, the marriage tie is easily loosed. Mourning customs are very strictly observed everywhere, while in many parts of New Guinea the images of their ancestors appear to receive a kind of worship from their descendants; religion, however, sits but lightly on the Papuan; and among the south-eastern tribes it is even doubtful if belief in a supernatural being exists at all.

But ancestor-worship may be taken as presumptive evidence of the idea of a future existence; and we may perhaps best define the Papuan religion as in a rudimentary condition. Belief in sorcery and witchcraft is rampant; and both sickness and lunacy are regarded as due to the latter influence.

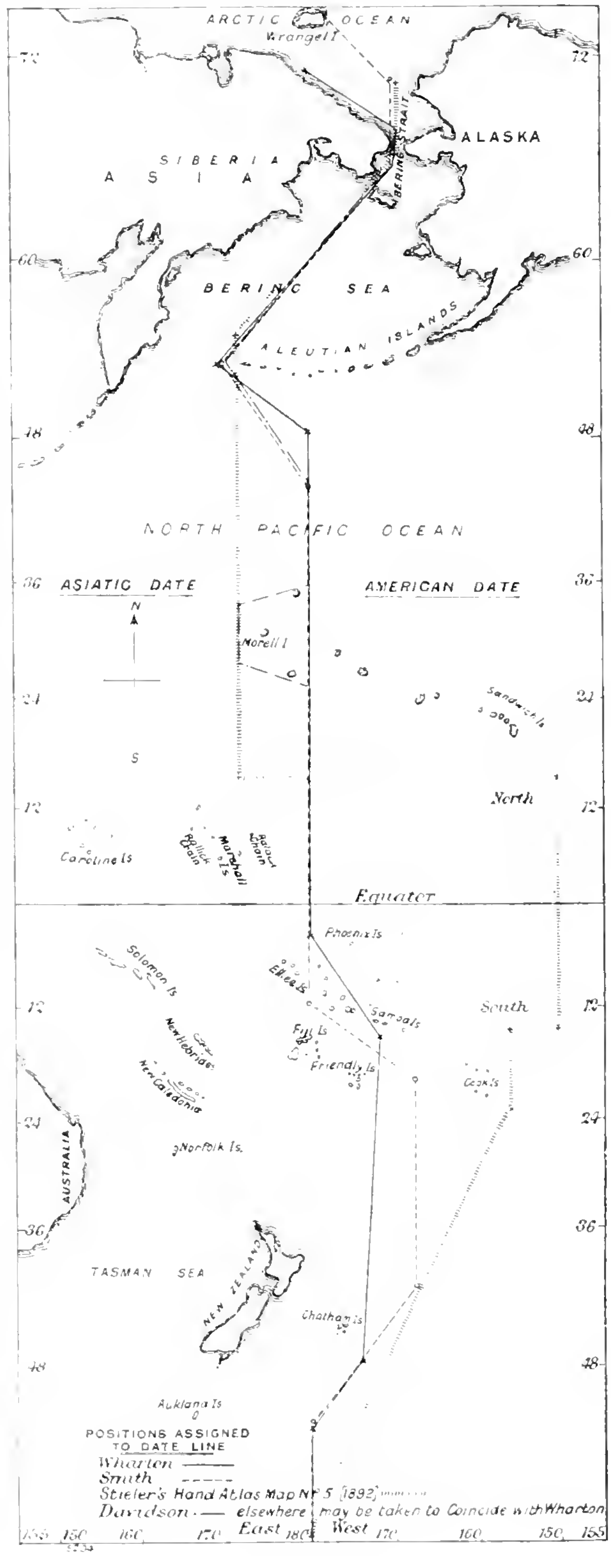
In certain districts tatooing is practised; but, with the exception of the short skirts of fibre worn by the women, the wardrobe of a Papuan is of the most limited description; the adornment of the hair being the chief sacrifice to fashion. It should, however, be added that the cartilage of the nose is frequently perforated to contain a boar's tusk, or a long pin cut from the giant clam (Tridacna), while shells of various descriptions are also worn as ornaments. No account of the Papuans would be complete without some reference to their pile-dwellings, which recall the habitations of the ancient Swiss lake-dwellers. These pile-villages, which are built in sheltered bays and supported on mangrove stems, are generally surrounded by water at high tide, but left more or less completely dry at the ebb. The coast tribes, who are in constant fear of those living more inland, are accustomed to escape from an attack by taking to their canoes before the enemy has time to gain access to their houses. But, as Dr. Semon remarks, in respect to the villages of Port Moresby, "the advantage of the plan seems impaired by the circumstance that the desired protection is rendered futile during ebb-tide, and I am sure that the wisdom of even a Papuan chief-commander will lead him to defer his attack till low water. Moreover, the inhabitants of Port Moresby are known as valiant warriors, and it is perhaps owing to ancient tradition rather than to fear of their enemies that they build their houses on piles and into the sea, never giving a thought to the original reason of this system."

WHERE THE DAY CHANGES.

By Dr. A. M. W. Downing.

Crossing the line for the first time must always be an experience of great interest to the traveller. Indeed, in former times the experience must have been a very disagreeable, as well as an interesting one, on account of the unpleasant character of the ceremonies that were considered appropriate to the occasion, and in which the tyro took unwillingly somewhat too prominent a part. In the bad old times to which I refer, people were known sometimes even to speak disrespectfully of the Equator.

But the Line of which I wish to speak—with entire respect—on the present occasion is not the Equator, but a line, in the neighbourhood of the 180th meridian, on which the day changes for the portions of continents and the groups of islands that lie thereabout, and which is, in consequence, called the Date Line. It is scarcely necessary to point out that to the Eastward-going traveller the local time is ever later and later, whilst to the Westward-going traveller it is ever earlier and earlier, than the time of the initial meridian. So that when the traveller, in the first case, reaches the 180th meridian his time is twelve hours later than that of the 1st meridian, and when the traveller, in the second case, reaches the same meridian his time is twelve hours earlier. The respective times of the two travellers (supposing them to meet on the 180th meridian) differ therefore by a day; that of the one coming from the Asiatic side being a day later than that of the one coming from the American side. When it is Thursday (suppose) on the American side, it is Friday on the Asiatic side. To set things right it is necessary for the traveller coming from the American side—in the case supposed—to skip Friday altogether, and to pass from Thursday to Saturday, whilst the traveller from the



The Date Line.

Asiatic side must have two "Fridays" in succession. This is the practice followed on board ocean-going ships when crossing the 180th meridian, and is as interesting an experience, in its way, as that of crossing the other "Line," to which I have alluded above.

But are not these things written of in "Tramps Abroad," and other such literature? They need not, therefore, be further dwelt on here, as the matter to which I wish particularly to draw attention is the actual position of the Date Line in its course from the Arctic to the Antarctic regions. This is necessarily affected by the configuration of the continents, and by the groups of islands contiguous to the 180th meridian. But it is obviously most convenient that the Date Line should follow that meridian as closely as political and geographical circumstances will admit. The positions of the Line, as assigned by the different authorities I have been able to consult, are laid down on the accompanying map, which is reproduced, by permission, from the "Journal of the British Astronomical Association," Vol. X., No. 4. The first thing that strikes one on looking at the map is the divergence of the different authorities. Notably the position given in Stieler's Hand Atlas is discordant, and, at the same time, deviates most from the 180th meridian. The Atlas is, however, dated 1892, and this position may perhaps be considered, if not obsolete, at least obsolescent. The line marked "Wharton" is due to Admiral Sir W. Wharton, the Hydrographer of the Navy; that marked "Smith" is taken from an article in the "Century Magazine" for September, 1899, by Mr. Benjamin E. Smith; that marked "Davidson" is due to Professor Davidson, of the University of California. It will be remarked that Wharton and Davidson agree very closely, except in one or two unimportant details, affecting a small group of islands. By adopting either of these lines, it may be assumed, with some confidence, that we know "Where the Day Changes," except, indeed, for the group of islands referred to, for which we must, I fear, for the present remain in doubt.

The further assimilation of the Date Line to the 180th meridian, though desirable, is difficult of realisation, as the position of the Line depends on the configuration of the parts of Asia and America concerned, and on the various circumstances which determine the direction in which the different groups of islands have intercourse with the outer world. But, judging from the past, progress in that direction, though slow, is sure, and will eventually give us a better approximation to a "straight" Date Line than we have at present.

Would it be to inquire too curiously to ask where the twentieth century begins? As to when it begins, we have recently, somewhat to my astonishment, had a Battle of the Centuries, in which one at least of the crowned heads of Europe has taken a side, and has taken the wrong side too!

The answer to the question, Where does the day change? also answers the question, Where does the century begin? And, as we have seen, a fairly definite reply can be given by a reference to the map, except in the case of a certain group of islands. When does the century change for that particular group? Ah, well! it would puzzle even a crowned head to answer that question.

PLANTS AND THEIR FOOD.—III.

By H. H. W. Pearson, M.A.

Carbon, the most abundant constituent of the plant's food, is drawn from the atmosphere in the form of Carbon dioxide.* Equally necessary, however, are the mineral elements supplied by mother earth. Of these the following are indispensable to most green plants: Phosphorus, Sulphur, Potassium, Magnesium, Calcium and Iron; further investigation may show that others are also essential in certain cases. For the comparatively few plants whose food requirements have been carefully examined these elements comprise all the mineral food requisite to support vigorous growth. Nevertheless, others, although they appear to play no direct rôle in the process of nutrition, are also absorbed.

These elements are stored in boundless quantities in the rocks of the earth's surface. In the ordinary processes of Nature the rocks are disintegrated and their fragments contribute to the formation of a loose carpet in which the roots of plants grow and extract therefrom a portion of their food. This is the soil, consisting usually of a mixture of rock-particles, disintegrated and partly decomposed, with humus (vegetable mould), an organic substance resulting from the partial decay of the dead bodies of plants and animals. This summary definition of soil is, be it noted, very far from conveying an adequate idea of its exceedingly varied structure and highly complicated nature. It is only quite recently that any serious attempt has been made to grapple with the enormous difficulties confronting the investigation of its structure and properties, with which the supply of plant food is very closely connected; until they are better understood our knowledge of the mineral food supply of plants must remain very imperfect. The chemical and physical properties of the soil are now being carefully studied, particularly in the United States; in this country and in Germany much has of late been discovered concerning the work of living organisms in the soil, more directly in connection with the preparation of the compounds from which Nitrogen, one of the most important constituents of the food, is obtained.

That soils differ from one another in a very marked manner is a fact easily demonstrated. Differences, for example, between the stiff clays of Suffolk, the sands of Bedfordshire, and the Buckinghamshire chalk, cannot be forgotten by one who has walked over them in wet weather. If specimens of these soils are dried and analysed it is found that diversity in chemical composition is much less than would be expected. The same elements are present in them all, and in proportions not varying much from one to the other. The distinctive characters gratuitously forced upon the notice of the pedestrian are due to their dissimilar behaviour towards water. This depends upon their physical properties, the relative sizes of the constituent particles, and not the elements the particles contain, for these are the same in all.

An analysis of a soil shows that it is composed of a great many substances; some are of no importance to plants. Those substances a plant demands from the soil it grows in are Potash, Lime, Magnesia, Iron, and Phosphoric and Sulphuric Acids (the latter in the form of phosphates and sulphates respectively). In addition to these, plants also take up others, for example, Silica and Soda, which appear not to form a necessary part of the food supply. Silica, indeed (and this is true of many other substances as well—is harmful to the plant if absorbed in too great quantity. The large quantities of Silica present in the external cells of grasses and some other plants—responsible for the "cutting edge" of many grass-leaves—are really rejected matter deposited by the plant in the outer cells to be out of the way, this being one of the few methods available to vegetable organisms of disposing of useless solid matter.

* Knowledge, March, 1900.

The most abundant constituent of almost all soils is Silica, of which quartz is a well-known form; as a rule it constitutes from 70 to 90 per cent of their bulk. Its preponderance is due to its insoluble and indestructible character, for, unlike most of the other constituents of rocks, its composition is quite unaltered by long exposure to the atmosphere. It exists in the soil in the pure state and in innumerable combinations with other elements known as silicates. The latter are nearly all as insoluble in water as is Silica itself. Silica and the insoluble silicates cannot be absorbed by the roots of a plant, for these are only able to take in liquids and substances held in solution. The greater bulk of the soil—viz., that part of it consisting of Silica or insoluble silicates—is therefore unable to contribute directly to the mineral food supply of plants. Every solid particle is indirectly concerned in the supply of water to the roots, in the absence of which no food can enter them, and therefore even the innutritious Silica holds an important post in the plant commissariat. In addition to Silica, nearly all soils contain small proportions at least of the essential substances named above, and these must all be accessible to the roots of a growing plant. Very small quantities of the latter will suffice, because they are all dissolved in the soil-water, which is a means of transporting them from any area containing them in abundance to another where any of them may be deficient; another reason is that the amounts actually required by growing plants are remarkably small. The following figures will bear out this statement, at least for the plant they refer to. It has been found that to produce 100 grammes (dry weight) of the Oat plant, it must be fed with the following quantities of the essential mineral substances:—†

	Grammes.
Phosphoric Acid	0·5
Potash	0·8
Lime	0·25
Magnesia	0·20
Sulphuric Acid	0·20
Total	1·95

These amounts are sufficient to enable the plants to grow. As a matter of fact, 100 grammes of the Oat plant contain, as a rule, about 3 grammes of mineral matter; in other words, the plant absorbs about half as much again as is necessary to support its growth. This extra quantity can to some extent be supplied by mineral matters other than those constituting the food proper. With this exception the plant refuses to recognise any attempt to replace the needful substances of its mineral food by compounds containing other mineral elements. If one essential substance is absent, or is present in too small quantity, then not only does the plant absorb a less quantity of that which is deficient, but also of all the other constituents of its food. In fact, a lack of one of these ingredients has the same effect as if the whole food supply were wanting in the same degree. As one imperfect wheel throws a watch out of gear so a shortness in the supply of one food constituent upsets the nutrition of a plant. It seems as if the appetite of the plant must be partly satisfied by definite quantities of certain mineral components—those we have called "essential"—under no circumstances replaceable by others; at a certain stage it becomes less fastidious, and although it demands a further supply of mineral food it is able to select it from a wider range of substances.

† Emil Wolff, quoted by Maercker; Berichte. 1897.

Lime is one of the most important constituents of soils. "A limestone country is a rich country," as the saying has it. The plant uses it not only as food, but also as medicine, or, rather, poison antidote, an edifying fact which will be noticed again. One of the numerous parts played by Lime in the soil is interesting as bearing upon the absorption of soluble silicates by plants. Silicate of Potassium, one of the very few silicates soluble in water, is present in most Clay soils and absorbed by roots. Excess of Silica has an injurious effect on plants. In the presence of certain compounds of Calcium—Lime, for example—Potassium silicate is decomposed, resulting in a Silicate of Calcium, insoluble, and the Silica it contains is therefore unable to enter the plant. Lime is, therefore, a very valuable constituent of Clay soils, since it prevents an undue amount of Silica being absorbed by the plants grown upon them. In some of its forms Lime is very soluble in water, and when present in the soil may be continually washed out by rain; to such an extent does this occur that the soil even of a limestone country frequently contains very little of it. A remarkable illustration of this is furnished by the soil of the Bermuda Islands. The Coral and Shell Limestone of these islands contains 54.5 per cent. by weight of Lime; during the disintegration of the rock, so much lime is carried away in solution that it constitutes less than 4 per cent. of the soil.‡

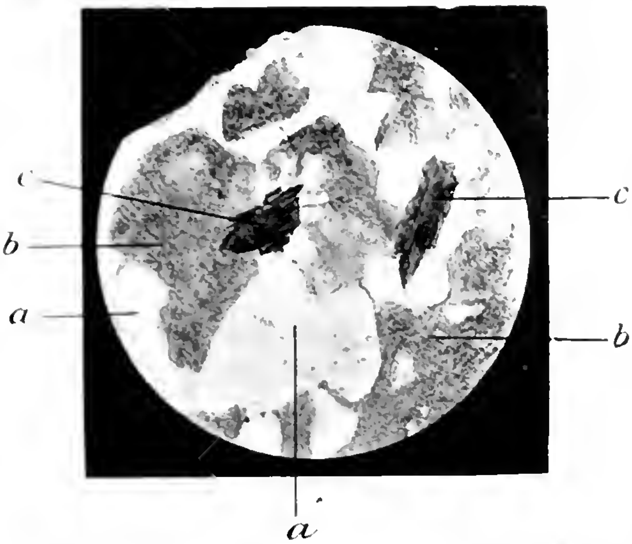
Since differences in chemical composition do not, as a rule, explain the varying degrees of fertility possessed by soils, to what then are they due? They must be ascribed to three principal causes hitherto very incompletely studied. There is, in the first place, the condition in which the food constituents are met with in the soil. In a fertile soil they are presented to the roots in sufficient quantity and in a soluble form in which they are easily absorbed. On the other hand, they may be so locked up that the plant is unable to extract as much as it requires in the time at its disposal—that is, during its growing period. This is often caused either by the soil-particles being insufficiently comminuted or by the insoluble nature of the compounds of which the essential elements form a part. Roots are of course made up of cells, and, as we have seen, plant cells are so constructed that only fluid materials can enter them. Plants, therefore, can obtain no mineral substances from the soil which are not soluble in the soil water, containing Carbon dioxide and other acids derived from living roots and from decaying vegetable matter.§ If the essential mineral ingredients are present in the soil in such a state that they can be neither decomposed nor dissolved by the soil water, assisted by the acids it contains, they are of no use to the plant. The barrenness of Granite crags is well known to all who have visited them in Scotland or elsewhere; and yet Granite contains all the mineral food that a plant needs. It is composed of three important minerals (see Fig.), Quartz (A), Felspar (B), and Mica (C).

Felspar and Mica contain the mineral constituents of plant food, but in Granite these minerals are enclosed in a network of Quartz, the insolubility of which has already been noticed. As long as the network is entire the nutritious constituents of the Felspar and Mica are so locked up that plants cannot get at them. When the

‡ "Rocks, Rock-weathering and Soils." Merrill. p. 359.

§ It was formerly stated that the solution of mineral substances in the soil was largely due to the action of acids set free by living roots. It is now believed, however, that CO_2 and, in a few cases, the acid Phosphate of Potassium, are the only solvents which roots evolve.

Granite, in the natural processes of disintegration, becomes sufficiently broken up, the Felspar and Mica are



A Section of Granite from Skiddaw, × 45. (Reproduced from a slide in the Woodwardian Museum, Cambridge, by kind permission of Prof. T. McKenny Hughes, F.R.S.) A, Quartz; B, Felspar; C, Mica.

exposed to the action of the atmosphere, and in consequence are decomposed, and from the products of their decomposition a fertile soil is formed.

A second very important factor in the fertility of the soil is the climate. It is the experience of planters and farmers all the world over that in a propitious climate almost any soil is fruitful, a fact partly though not entirely due to the direct effect of a favourable climate upon the vegetation. The effects of different degrees of rainfall, temperature, sunshine, and other influences included in the term "climate," upon the soil are exceedingly diverse, and very imperfectly understood. In some parts of the world where the climate changes very suddenly in passing between two places situated within a few miles of one another, corresponding changes in the fertility of the soil appear to be due entirely to climatic differences. In the central plateau of Ceylon, for instance, there are several remarkable isolated peaks rising to 2,000 or 3,000 feet above the general level of the country. The eastern slopes are, as a rule, preferred by tea planters, because the soil is found to be more fertile than on the western side. The difference is undoubtedly to be attributed to the climate, though the precise manner in which the soil is affected by it is not well understood. The western slopes of these hills are subject at certain seasons to the biting winds of the South-west monsoon, and are very constantly enveloped in mist; on the opposite side the winds of the North-east monsoon are less injurious to vegetation and the sun is much less obscured by cloud. When the slopes were covered by virgin-forest these conditions caused a more luxuriant vegetation to exist on the eastern faces than on the western, and in consequence the soil on that side was more copiously enriched by humus one of the most important contributors to fertility in a soil. This is by no means the only way in which the soil is affected by climatic differences. These have an important effect upon the decomposition of the soil-particles continually taking place in order to make up the deficiencies caused by the demands of existing and increasing vegetation. To what extent and in what manner the climate influences this process are questions which have as yet received no very clear answers, and a consideration of them is too wide for our present limits. Rain is also an important fertiliser of the soil, for it adds to it the "impurities" swept down out of the atmosphere, and in many cases brings down solid matter from the land at higher levels. It has been proved that a very large proportion of a plant's mineral needs can be satisfied by the substances chiefly in the form of dust thus carried down from the atmosphere.

The capability of a soil to support vegetation is also in a very important manner due to its power of retaining part of the water falling upon it as rain. This depends partly upon the size of its mineral particles and also upon the amount of humus (vegetable mould) it contains. Humus has a very strong avidity for water, and largely increases the water-holding power of the soil. It has been said, probably with truth, that, from the point of view of the plants it supports, the most important property of the soil is its behaviour towards moisture —in other words, the relative amount of water it is able to hold by capillarity. The characters of the water thus retained, and some interesting facts concerning the food substances held in solution, remain for further consideration.

From a microphotograph kindly taken for this paper by Mr. H. Stanley Jevons, F.G.S.

A TEMPLE OF SCIENCE.

By W. Alfred Parr.

Among the many museums and galleries, filled with the priceless treasures of past generations, with which Florence abounds, and which render the city of Dante a veritable "Mecca" alike to the artist and the student, perhaps none offers a greater interest to the scientific, and more especially the astronomical, visitor than that Temple of Science known as the "Tribuna di Galileo." This richly decorated hall, in which are worthily enshrined some of the most interesting and valuable scientific relics relating to the life and work of Galileo, and which vies in point of interest with the picturesque old tower known as Galileo's Observatory, described by me in a former number of Knowledge,* forms part of the Museum of Physical Science, and was inaugurated in 1840, on the occasion of the assembly at Florence of Italy's principal scientific men. Dedicated, as it is, to the memory of the great Tuscan astronomer, it was but fitting that the structure itself, as well as the paintings, sculptures, and mosaics with which it is so richly adorned, should be representative of the best talent of Tuscany; and that the artists entrusted with the erection and decoration of this memorial to their illustrious compatriot succeeded in worthily acquitting themselves of their task, may be seen from the accompanying photograph.

On every side are depicted interesting episodes in the life of Galileo, from the time when, as a young student, he watched the swinging lamp in the Cathedral of Pisa, to the time when, old and blind, and in the retirement of his villa at Arcetri, he dictated the account of his researches to his two celebrated pupils, Torricelli and Viviani; while in the centre of the apse, dominating the whole, stands Professor Costoli's statue of the great astronomer. The painting in the ceiling immediately

* *See* Knowledge for July, 1899, p. 157. The tower is now the property of Count Paolo Galletti.

above the statue, and plainly visible in the photograph, represents Galileo in the act of demonstrating the merits of his newly constructed telescope to the assembled senate at Venice.

Ranged along the walls are glass cabinets, containing many valuable instruments dating from the time of Galileo and his School, but it is in the two cabinets on either side of the statue that our chief interest centres. In the one to the left of the spectator is preserved, carefully mounted in an elaborate hexagonal frame of worked ivory and ebony, the object-glass which Galileo fashioned with his own hands. This precious bit of glass, if one may believe the Latin inscription on the frame, afforded the great astronomer his first glimpse of Jupiter's satellites, and thus enabled him to announce to the world the great discovery which firmly established

The Tribuna di Galileo in the Museum of Physical Science at Florence. (Photo by Alinari, Florence.)

the Copernican doctrine, and which elicited Kepler's famous message of congratulation to his fellow worker, parodying the last words of the Emperor Julian: "Galileo vicisti!"† The little lens, barely an inch and a half in diameter, which sufficed to reveal the four "Medicean Stars" to the eye of the "Tuscan artist," compares strangely with the great thirty-six inch object-glass on Mount Hamilton which, two hundred and eighty-two years later, added a fifth member to the little group forming the Jovian system. Preserved in this same cabinet, and just discernible in the photograph above the frame containing the object-glass, are two of the first telescopes which Galileo is said to have constructed.

A somewhat gruesome relic of the great man is preserved in the cabinet to the right of the spectator. Mounted on a short marble pillar, adorned with the usual allegorical Latin inscription, is a crystal vial containing the index finger of one of Galileo's hands. It was severed from his body just before the latter was consigned to its last resting place beneath the grand monument prepared for it in that Westminster Abbey of Florence, the Church of Santa Croce.

The remaining cases contain a valuable collection of astronomical, nautical, and geodesical instruments formerly belonging to the Accademia del Cimento, the famous institution which, rising as it were, from the ashes of Galileo, counted among its members such men as Borelli, Viviani, and Redi, and which chose for its motto the significant words, "Provando e Riprovando."

Some old telescopes with wooden "bodies" by Torricelli of Florence, dating from the year 1644, together with others in quaint leather coverings, embossed with curious gilt ornamentations, constructed by Campani of Rome in 1666, are also preserved here and serve to complete a collection which, alike to the student and the antiquarian, is of absorbing interest throughout.

† "Galileo, thou hast conquered!"

ASTRONOMY WITHOUT A TELESCOPE.

By E. WALTER MAUNDER, F.R.A.S.

IV.—A TOTAL SOLAR ECLIPSE.

IT is the misfortune of the British Isles to be so completely shunned by total eclipses of the sun that a century and three-fourths has passed since the last visible in England, and more than a quarter of a century has still to run before this country will be favoured with the next.* Yet the ease of modern travel brings the phenomenon within the reach of so many that it may be well worth while to glance at the various kinds of work which can be undertaken by "astronomers without telescopes," especially as we are now within a month of the time of an eclipse the track of which may be reached by a three days' journey from our own shores.

It should be borne in mind by all who are favoured with a good view of so rare a phenomenon as that of a total eclipse of the sun, that there is a kind of moral obligation upon them not to let the opportunity pass entirely without profit. "The giddy pleasure of the eye" is no excuse for selfishness. Each one should do something, make some record, which may hereafter be of service to others in the solution of some of the problems which are eclipse presents. We owe an inestimable debt to those who preceded us who did leave such records, and we can only repay that debt, by in like manner, doing our best to leave material as useful for the benefit of those who shall in their turn succeed to us.

First of all, the most obvious work for anyone to undertake, who watches a total eclipse without a telescope, is to draw the corona. This may seem a very trivial matter, and when the strange discrepancies between different sketches are noted, a very useless thing to attempt, especially in view of the entrance of photography into the field. But it is not so. The chief fact that we have as yet established with regard to the corona is that it varies in form and character with the sun-spot cycle, and this fact, though supported by the photographs, was demonstrated by the comparison of drawings. Then again the careful examination of drawings has shown them to be far more trustworthy than a cursory look would suggest. The wide differences between different sketches has often been due to the sketchers choosing different sections of the corona; one choosing the brightest inner corona, another the fainter and more irregular contour, a third the faintest extensions. The results have really not been contradictory but rather supplemental of each other. Nor has photography entirely superseded the work of the sketcher even yet. The coronal streamers, often shown in drawings, were photographed in the eclipse of 1898 for the first time. The previous failure of photographs to record them had occasioned their very existence to be denied in some quarters, and had cast unmerited suspicion upon the drawings which delineated them.

The work of drawing the corona is, however, not one to be done off-hand. The intending artist should be one who has already acquired skill and quickness in draughtmanship. The time of an eclipse is terribly short—it will scarcely exceed one minute at most stations on May 28th next—and the object is bizarre and unfamiliar. There should be frequent practices beforehand, either upon drawings of the corona, held at a distance of 107 times the diameter of the eclipsing moon, or, perhaps better, upon little wisps of cirrus cloud. But in any case the time from the first sight of the object to the completion of the sketch must be rigidly confined to the time of the expected duration of totality. Quickness to see and record is the first essential for coronal sketching.

The next point to be noted is the need for fiducial lines by which to orientate the drawing. This may be done by providing a plumb-line right across the line of sight. If the weight at the end of the plumb-line dips into water, it will serve to steady it against vibration with the wind. Mercury, distant about $2\frac{1}{4}°$ from the sun, in the forthcoming eclipse, will supply a further and most excellent reference point both for direction and distance.

If several sketchers can combine they should portion out the corona between them before the eclipse begins, the vertical line being adopted as one of the dividing lines, and if four workers are present, a line parallel to the horizon might be another, thus giving each observer a quadrant. A fifth observer might make a rapid outline of the entire corona as a basis for combining the four quadrantal sketches. In so short an eclipse it would be a distinct advantage to be able to confine the attention to a portion only of the phenomenon.

The sketchers should be careful to indicate as precisely as possible the positions of any red prominences, as these can be verified either from photographs or from observations with the spectroscope. Distances from the limb of the dark moon should be carefully estimated in terms of its diameter.

In some former eclipses, notably in 1878, the brightest inner corona has been screened off by means of a black disc, so as to leave the eye more sensitive for the detection of faint coronal streamers. This is not recommended as it is a troublesome and very doubtfully useful device. But all intending sketchers should be most careful to avoid dazzling their eyes during the coming on of the partial phase, and should rest them as much as possible shortly before totality.

White chalk on purplish blue paper is an admirable material for representing the corona. Notes as to any colour or colours perceived in the corona should be made.

Quite another class of work may be taken up by those who have keen eyesight, in the search for stars. The sun is in a specially rich portion of the heavens, during the eclipse of May 28th, near Aldebaran and the Pleiades, and a great number of stars should consequently be seen. Orion, Sirius, Procyon, Castor and Pollux are all well placed. Mercury is only $2\frac{1}{4}°$ distant from the sun below it; Venus practically at her greatest brilliancy will be nearly in the zenith. To note which stars are seen, when they are first glimpsed, and when lost, would be of some value as a register of the clearness of the sky, and of the brightness of the eclipse, as well as for comparison with the records of old eclipses wherein the appearance of stars was observed.

The zodiacal light should be looked for, for though the chances against seeing it are very great, a single clear record of its appearance during an eclipse would be of the utmost value, and might decide at once whether its axis coincided with the ecliptic or with the solar equator. The ecliptic at the time of totality is only inclined a few degrees to the vertical.

The observations of the "shadow bands" is one of some interest, and as it only requires a white surface and a few light rods, a large number of observers should be forthcoming.

It must be remembered that the bands are usually very faint, and have to be definitely looked for. A white surface must be prepared to receive them; either a white sheet, which may be fastened down to the ground, or set up vertically on an upright frame, or a whitened wall. The surface should be marked with two straight black lines, one foot apart, that the intervals apart of

* See diagram at page 119 for Eclipse as visible in England.

the bands may be correctly judged. A rod should be placed to mark the direction of the bands themselves, as seen at the beginning of totality; and another to mark their direction of motion; another pair being used for a similar purpose for the bands seen at the close of totality; and after totality is over the most careful determinations must be made of the directions of the rods, and of the position of the sheet or wall. The following questions drawn up by Mr. E. W. Johnson for the assistance of the Members of the British Astronomical Association should be answered.

QUESTIONS.

1. How long before totality did the bands appear?
2. What number of bands were visible, say, in 10 seconds?
3. What was the direction of motion?
4. Where they inclined to the direction of motion?
5. What was the direction and force of the wind?
6. Did they come uniformly, or in batches?
7. What was their speed?
8. What was the width of the bands?
9. What was the distance apart of the bands?
10. Were they very faint, or clearly defined?
11. Was their direction after totality the same as before?
12. How long after were they visible?
13. Did you see any bands during totality?

The subject of shadow-bands leads naturally to meteorological work, for there is no doubt that the direction of the wind affects the direction of the motion of the bands. The meteorological observer should therefore provide himself with some form of vane and some means of ascertaining the force and speed of the wind. The wet and dry bulb thermometers would seem to be the next most important instruments to take, that the change in temperature and in saturation of the air might be marked. The barometer would come in the third place. It is of course desirable that observations should be made at regular intervals for some days both preceding and following the eclipse, especially at the same hour of the day as that when the eclipse takes place.

Those who find themselves about to witness the eclipse yet without any instruments or any preparations for observing should not let it pass without some record. They should note the appearance of the sweep of the shadow over the country as it comes and as it goes; the colours of sky, land and sea should also be noted, the sky being divided into three regions—namely, overhead, at sunlight, and near horizon.

Photographic cameras come very close to a definition of a telescope, and hence should be excluded from the scope of the present paper. Yet as in all probability there are some hundreds of possessors of cameras for every one who possesses an astronomical telescope, it is perhaps not superfluous to remind photographers that a very large field is open to them. Cameras with a focal length of two feet and upwards may be profitably used upon the corona itself. In this case the camera should be firmly fixed and exposures not exceeding half a second should be given. If the focal length be not more than 15 times the aperture, this with an extra rapid plate will probably be found quite sufficient. For shorter focal lengths shorter exposures or slower plates may be used.

Hand cameras may be profitably employed for photographing the landscape during the approach and recession of the shadow. A series of photographs taken at five minute intervals with a uniform speed of shutter, such as Miss Bacon took at Buxar in India, would give a very interesting and certainly very pretty record of the increase in the darkness as the eclipse comes on.

Finally, a valuable record of the total light of the eclipse can be obtained by exposing a plate in a printing frame to the light of the corona during totality. Portions of the plate can be exposed for different lengths of time or the plate itself may be placed under some form of sensitometer. Further information would be obtained by using as well different coloured screens in connection with plates of various coloured sensitiveness.

A PHOTOGRAPHIC SEARCH FOR AN INTERMERCURIAL PLANET.

It has not been, in general, the policy of the Harvard College Observatory to send expeditions to observe total eclipses of the Sun. First, since in the case of cloudy weather, no return is obtained for the expenditure of a sum of money which is often large. Secondly, if clear, the results in many cases are only a series of pictures of the corona and protuberances which add but little to our knowledge of them. Therefore, when officers of this Observatory have observed eclipses, it has generally been largely at their own expense. When, however, a new problem presents itself some aid is rendered from the funds of the Observatory, in the construction of instruments and for similar expenses. The following plan for observing the Eclipse of May 28th, 1900, has been prepared by Professor W. H. Pickering:—

It is a fact capable of demonstration, that the faintness of a star that may be photographed with a given instrument, against a bright background of sky depends, within certain limits, directly on the length of the focus of the lens, and is independent of its aperture.

In the Harvard Observatory Annals, Vol. XVIII., p. 104, it was shown that if the place in which to look for the Pole Star is known, that three minutes after it first becomes visible to the naked eye in the evening, the light of the sky in its immediate vicinity is of about the same photographic intensity as that of the sky surrounding the Sun at the time of a total solar eclipse.

Starting with these two fundamental facts, a series of experiments has been undertaken with a photographic lens having an aperture of 3 inches, and a focal length of 11 feet 4 inches. The curves adopted were those employed in an ordinary landscape lens, and it was found that the field was large enough to cover nine 8 × 10 photographic plates arranged in three rows of three each This result was only obtained, however, by attaching the plates to the interior of a concave surface of double curvature, and thus obtaining a curved field.

By giving an exposure of one minute in the region of the Pole, with this instrument, three minutes after the Pole Star first became visible, it was found that the light of the sky was sufficient to darken the plate appreciably, but not so much as to prevent stars of the eighth magnitude appearing with sufficient intensity to be found by a careful search, in the larger part of the field of view.

Three similar lenses have now been ordered, and the four will be placed upon one mounting, in such a manner as to photograph a region extending for sixteen degrees on either side of the Sun, and having a breadth of ten degrees throughout its length. Throughout nineteen degrees of its length every portion of the region will appear upon two separate plates.

The satellites of Mars, Jupiter, and Saturn all revolve very nearly in the equatorial planes of their primaries, and in the same manner Mercury revolves very nearly in the equatorial plane of the Sun, which is inclined about seven degrees to the plane of the ecliptic. It is, therefore, reasonable to suppose that bodies still nearer to the Sun would revolve in the same plane. It so happens that the Earth passes through this plane about one week after the date of the solar eclipse of next May so that there is a strong probability that if an intermercurial planet exists, it will appear somewhere upon the narrow line forming the projection of this plane upon the celestial sphere. It will be seen, therefore, that the date of this eclipse is especially favourable for the proposed search.

We have very good evidence, from the visual observations hitherto made, that no intermercurial planet brighter than the third or fourth magnitude exists. We possess no evidence whatever for or against the existence of fainter bodies in this region having sufficient size to be properly called planets. We are reasonably certain that the immediate vicinity of the Sun is filled with countless bodies of such size as to be properly described as meteors.

If we assume that at its average brightness, Mercury is of the first magnitude, and that the albedo of an intermercurial planet is the same as that of Mercury, we shall find that at the distance of Mercury from the Sun, a body of the eighth magnitude would be 120 miles in diameter. If its distance from the Sun was but one half as great, its diameter would be 60 miles, and if but one quarter as great, or 9,000,000 miles, it would be 30 miles in diameter. Judging by the analogous case of Jupiter, the existence of such a small planet is quite possible.

Should such a body exist, and should it appear upon the plates, which it is proposed to expose somewhere in the State of Alabama, we should still be entirely at a loss to compute the orbit, or to determine the distance of the body from the Sun. If, however, other photographs of it should be obtained with a similar apparatus, in Spain or Algeria, we should then be enabled to compute an approximate orbit, based upon the assumption that it moved in a circular path. It might then be found again at the following eclipse, which occurs a year later, and a more accurate elliptical orbit could be computed for it. While it is desirable that the duplicate apparatus should be also furnished with four lenses, this is not necessary, and in case the planet should be found upon our plates, two lenses, one photographing the region on each side of the Sun, would be all that would be necessary to independently make the discovery, and furnish the elements necessary to compute the circular orbit. It is in the hope of inducing some European observer to supply himself with this apparatus that the present article has been written.

The foregoing plan appears to be of sufficient importance to justify aid from the Observatory. Preparations have, therefore, been made to give it a careful trial. It is hoped that this early publication may permit similar observations to be made at a second station sufficiently distant to reduce the danger of failure from clouds, and if an intermercurial planet should be found, to furnish an approximate determination of the form of its orbit.

Edward C. Pickering.

Harvard College Observatory,
February 13th, 1900.

THE PHOTOGRAPHY OF CLOUDS.

By Eugène Antoniadi, F.R.A.S.

(Continued from page 81.)

Some additional references to exposure may be given in the data accompanying the annexed photographs:—

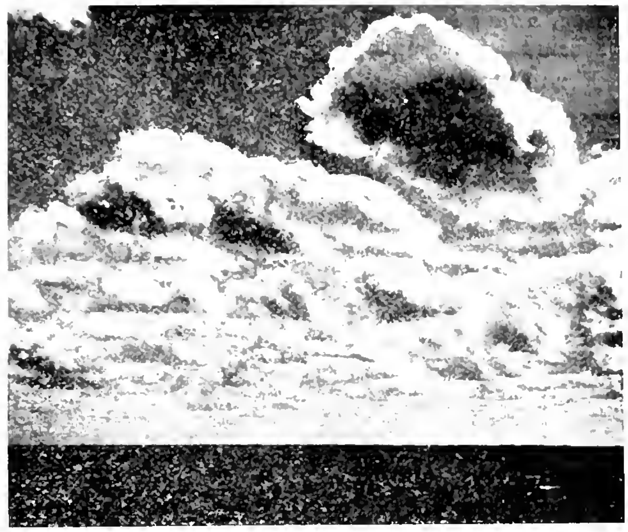


Fig. 1. Cumuli forecasting fine weather, 1899, August, 29d. 9h. 45m. a.m., local time.

Subjoined Plate, Fig. 1.—Cirro-cumulus, following and forecasting wet weather. Photograph taken with the

Fig. 3.—Photo[illegible] primary and secondary Rainbows, taken at Juvisy [illegible] September, 28d. 5h. 3m., local time.

10½-inch object glass, whose focal length is 5·12 inches. Yellow screen of moderate intensity, on account of the deep blue sky. Stop=$\frac{f}{11}$. Exposure=1 full second.

Plate, Fig. 2.—Nimbus covering the setting sun, whose rays gild the upper edge* of the cloud bank, during rainy weather. Showers are actually seen falling from the cloud on the horizon. Same object glass. No yellow screen, owing to the absolute lack of blue. Stop=$\frac{f}{32}$. Exposure=$\frac{1}{10}$ second.

Figure 1 (text).—Peaceful cumuli during warm weather. Same glass. Faint yellow screen. Stop=$\frac{f}{16}$. Exposure =$\frac{3}{5}$ second, in strong sunshine.

Figure 2.—Sunset behind ragged clouds. Same glass. No screen at all. Stop=$\frac{f}{22}$. Exposure=$\frac{1}{15}$ second.

Figure 3.—Rainbow, with a nearly horizontal sun. The secondary bow is very marked on the negative; but there are no supernumeraries. Same glass. No yellow screen. Stop=whole aperture. Exposure=$\frac{1}{25}$ second. *Short exposures are particularly effective on rainbows.*

The excellent isochromatic plates of Messrs. A. Lumière et ses Fils, of Lyons, have been invariably used here by M. Mathieu and the writer in their attempts at cloud photography.

The development of cloud plates is done in the ordinary fashion, though plates sensible to the red should be developed with a very weak red light only, in order to avoid fogging. The solution should, of course, not be too strong, while haste is particularly nugatory. A slow, methodical development always yields good results. At Juvisy, pyrogallic acid is used in preference to other substances. An enfeebled old solution, intensified when necessary, is, moreover, preferable to a new one. Finally, the question of the moment of stopping the development is one which experience only can decide.

* These golden fringes, due to the illumination of the cloud from behind, are also visible round cumuli at night during lightning flashes. In a paper published however, in 1899, in the "Bulletin de la Société Astronomique," a M. Touchet, quite misunderstanding the nature of the occurrence, introduced the unscientific notion of "lightning ribbons running along the clouds' edges."

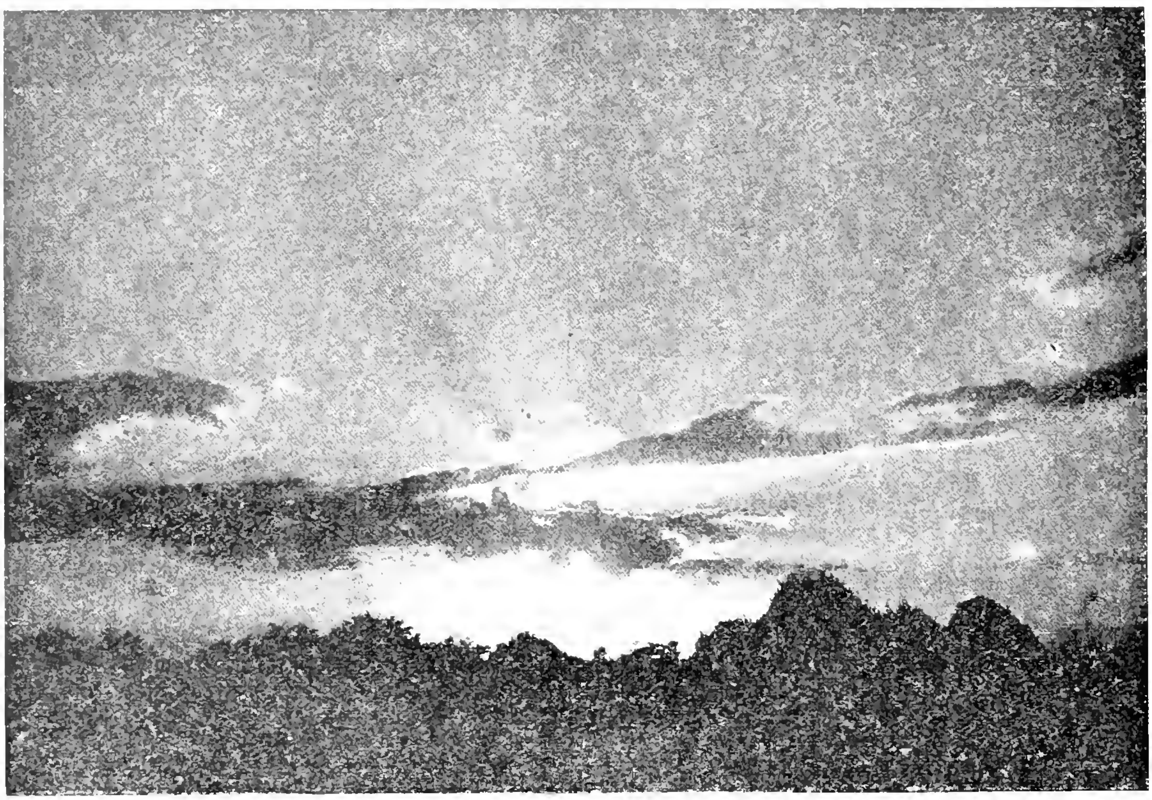


FIG. 2.—Sunset effect, 1899, September, 24d. 5h. 25m., local time.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

IS THE STELLAR UNIVERSE FINITE?

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I cannot enter into this discussion, but may I suggest, as a point which appears to me to have been overlooked, that the Ether as a transmitting medium for light is limited in extent, and belongs specially to a cluster of stars of which our solar system is a part, and that it thins out at a finite distance from that cluster (in the same way that our atmosphere thins out at a distance from the earth) until it is incapable of transmitting light. In that case, the Stellar Universe might be infinite, but there would be a "rapid decrease in the luminosity of the stars" at a great distance from us, owing to the decreased transmitting power of the ether; and though the stars were just as numerous beyond the ether, there would be nothing to transmit their light.

GEO. PHELPS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Mr. Anderson says that "individually they" (the brighter and fainter stars) "do not lose the same

Fig. 1.—Cirro-cumulus, 1899, September, 25d. 2h. 25m., Mean Local Time.

Fig. 2.—Rain-Cloud, [illegible] Showery Weather, 1899, Ju[illegible] [illegible]d. 6h. 55m. p.m., Local Time.

CLOUD PHOTOGRAPHS TAKEN AT JUVISY.

proportion of their total light" by atmospheric absorption and similar causes. May I ask by what experiments or observations this is proved? All the photometries with which I am acquainted proceed on the opposite principle. In none of them is a different estimate made for atmospheric absorption in the case of bright and faint stars. Prof. Pritchard's photometer depends on the thickness of a plate of neutral-tinted glass which is required to extinguish the light of the star. It would fail if there was a more rapid (proportional) extinction in the case of faint stars than of bright ones.

When a star is near the limit of vision a small reduction in its light renders it imperceptible as a separate object. A field-glass, however, will suffice to discover it. With a further reduction in the light a telescope would be required, and we should afterwards have to discard our first telescope and use a more powerful one. But can anyone suppose that in these cases it produces no effect at all unless it is separately visible? Mr. Anderson disavows this argument, however, and, therefore, I need not discuss it.

Considering the great number of different places at which observations are now made, and the fact that star-gauges are usually made at the most favourable time for observation, I can hardly believe that there are any stars brighter than say the 12th magnitude which have remained undiscovered because they were always too near the horizon to be visible with a telescope calculated to show all stars down to the 14th magnitude. (Of course the visibility or invisibility of faint stars depends entirely on the instrument employed.)

Supposing that with our present instruments no star below the 10th magnitude can escape us, why should we not trust our star-gauges up to that magnitude? And why should we not use the general luminosity of the sky as an indication of the distribution of still fainter stars?

I am not writing in favour of either a finite or an infinite Universe. I only desire to call the attention of astronomers to one of the unsolved problems which the science presents; and I am surprised to find so many writers both in your columns and elsewhere dealing with it on popular or metaphysical grounds rather than as a scientific problem.

W. H. S. MONCK.

P.S.—In my last letter "α Centauri" was printed "and Centauri." The reader will no doubt have seen the mistake.

[I must express my full agreement with the concluding words of Mr. Monck's letter. The question of the shape and extent of the general sidereal universe as it presents itself to us seems to me an interesting and important one, and any mode of enquiry which would enable us for instance to form an estimate of the mean distance of the Galaxy and of its mean depth should I think be welcomed and carefully examined. But the general question "Is the Stellar Universe finite?" becomes at once not a physical but a metaphysical enquiry, and hence leaves the domain of astronomy, and except as a purely mental exercise I see no value in it. How easily even the keenest and most trained minds may go astray on the subject may be learned from Prof. Newcomb's paper in the March number of the "Windsor Magazine." He writes "It can be shown mathematically that an infinitely extended system of stars would fill the heavens with a blaze of light like that of the noonday sun." There is a tacit assumption here that the stars are on the average uniformly distributed in space, an assumption which for nearly a century astronomers have known to be untrue.

I must ask, therefore, that correspondents in future will leave the general and metaphysical question entirely alone, and confine themselves to the question of the actual distribution of the known stars.

E. WALTER MAUNDER.]

WIRELESS TELEGRAPH RECEIVER.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—One evening last summer I was using the receiver in the ordinary way in connection with a Morse printing machine; it was a dull evening with a good deal of thunder about; and I noticed that a dot was printed at every flash of lightning. Of course that would be expected, since the receiver was not protected in any way, but when I joined up a small galvanometer in place of the Morse machine, I found greatly to my surprise that the needle of the galvanometer was affected by the lightning through the coherer, an instant before the flash was visible to me. I noticed it several times. The only explanation I can think of is that the electric discharge caused by the lightning has a quicker effect upon the coherer than upon the human brain or nerves.

NORMAN ROBINSON.

[The really important conclusion to which your correspondent's observations seem to point is this:—The galvanometer used was sensitive to something which occurred immediately before the lightning flash was made manifest, as regards which, it seems clear that the "recorder" took no note of it. Two questions are at once suggested: What was this something, and, was the galvanometer in no way affected by the immediately succeeding, and expected, effect which caused the Morse to "dot"? Stating the second question in another way, "Did the needle give but one kick?"

Again, as regards the producer of the effect alluded to, apparently it was Hertzian, Electro-magnetic, or Electro-static. Possibly it was forces of these three natures acting together, or any two of them in conjunction—if not a single one. Unfortunately Mr. Robinson gives us no details as to the windings (and self induction co-efficients) of the instruments which he used—and interchanged. However, the subject is one of great interest, and it seems that no one has hitherto wandered into the path indicated.—HOWARD B. LITTLE.]

A CLOUD OF DRIED BEECH LEAVES.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The following may be interesting, not only as an unusual occurrence, but as bearing on the question of aërial transportation of seeds, etc.

At about four o'clock on the afternoon of Sunday last (April 1st), my attention was arrested by the fall of numbers of dried beech leaves. On looking up I found that the leaves were passing in large numbers from east to west, and as high as the limit of vision. Many appeared to be mere specks, whose height and motion promised them a journey of some miles at least. The shower continued for perhaps twenty minutes. The fall was noticed by many persons here, who were unable to account for it, as there are no beech trees within two miles at nearest. Probably the leaves had been raised by a whirlwind, and at a very considerable distance east of this neighbourhood.

A friend who was some three miles east of my station, witnessed the phenomenon, and states that by the aid of a field glass he could see leaves still higher than those visible to the naked eye, and yet felt that he had not even then reached the highest.

The morning had been clear and bright, but at the time of this occurrence the east sky was covered with a thick thundery-looking haze. There was no surface wind. Barometer steady at about 30.2 inches.

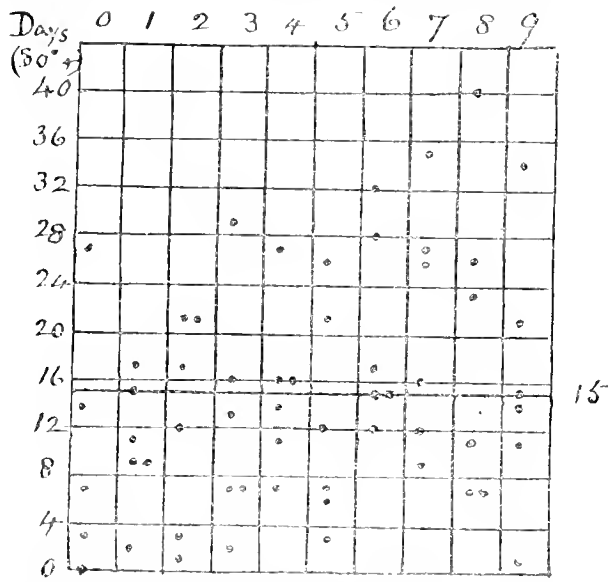
Wallingford, Berks. T. H. Astbury.

LONDON SUMMERS

TO THE EDITORS OF KNOWLEDGE.

Sirs,—A short time ago I offered some evidence for a connexion between our summers and the sunspot cycle of about eleven years. While still of opinion that much may be said for this view, it has of late seemed to me worth consideration whether a shorter period, say of about ten years, might not give a better account of the facts.

Perhaps you will allow me to supplement that article with a diagram in which the fifty-nine Greenwich summers, 1841-99, are grouped according to the number in which the year ends (years ending in 0, in 1, in 2, &c. and so on up to 9). Each dot represents a summer



Distribution of 59 Summers (Greenwich) in 10 Columns.

season, and shows by its position how many days with temperature 80° or more it had. The average is 15 (represented by a line).

(As the series begins with 1841, the column 0 is one dot short.)

One is struck, I think, by the greater coolness, generally, in the earlier part, and the general rise in position of the dots as the decade advances to the 6-8 groups.

The averages of the columns come out as follows:—

0.	1	2	3	4	5	6	7	8	9.
10·2	10·5	12·5	12·3	15·2	12·5	19·8	20·8	15·7	16·0

Thus the summers of years ending in 7 have had, on an average, more than twice as many of those hot days as the summers of years ending in 0.

Four of the first five values are below the general average; four of the last five values above it.

From this point of view, then (and it is a purely empirical one), cool summers seem to be more probable than hot ones in the immediate future, and we should hardly expect any extremely hot ones. It remains to be seen whether the next sixty summers will have the same general distribution as those now considered.

Other facts pointing in the same direction might, I think, be given, but I will not here enlarge on the subject. Alex. B. MacDowall.

Ornithological Notes.—In the absence from England of Mr. Harry F. Witherby, the Ornithological Notes are held over.

Obituary.

Science loses one of her chief ornaments by the death of Professor St. George Mivart, f.r.s., who expired on the 1st April, 1900. Born in November, 1827, he was educated at Clapham Grammar School, Harrow, and King's College, London. In 1851 he was called to the Bar, but, attracted by scientific studies, he became lecturer at St. Mary's Hospital Medical School in 1862. Dr. Mivart was at variance with Darwin as regards "natural selection" and evolution as applied to the human intellect, and in the early seventies engaged much in controversy on these subjects, always with great literary skill, however his opinions might differ from those of his opponents. In 1867 he was elected a Fellow of the Royal Society, and in 1869 he became Vice-President of the Zoological Society. Dr. Mivart was an accomplished lecturer, well known in that capacity, not only in London but throughout the country. Among his works may be mentioned "The Genesis of Species," 1871; "Lessons in Elementary Anatomy," 1872; "Man and Apes," 1873; "Lessons from Nature" and "Contemporary Evolution," 1876; "The Cat," 1881; "Nature and Thought," 1883; "The Origin of Human Reason," 1889. Dr. Mivart's last days were occupied by a controversy with the heads of his church. The correspondence in the "Times" of January 27 and 29, 1900, indicated that for some years a conflict had been steadily growing in his mind between the force of private judgment and the necessity of submission to authority.

Professor John Henry Pepper, who died last month in his 80th year, attained fame by means of the "ghost illusion" which in the sixties was very much in vogue at the theatres. At the Polytechnic in Regent Street the exhibition succeeded both scientifically and as a commercial enterprise. Prof. Pepper was the author of several popular science books, and these, together with his skill as a lecturer, did much to attract public attention to science subjects. "Pepper's Ghost" is said to have been suggested to the inventor by observing the images of his fellow passengers while riding home in a train late at night, the glass windows reflecting their faces on the "darkness" outside.

Notices of Books.

"Photographs of Stars, Star-Clusters, and Nebulæ, together with Records of Results obtained in the Pursuit of Celestial Photography." By Isaac Roberts, d.sc., f.r.s. Volume II. (London: Knowledge Office, 326, High Holborn, W.C.) 1899. Price 30s. It is a very difficult matter for astronomers living at the present day to fully estimate the value of Dr. Isaac Roberts' series of stellar and nebular photographs of which the second volume has just been issued. That they are very beautiful photographs of beautiful and wonderful objects is clear; it is patent to the most casual glance. That they will amply repay the study of Dr. Dreyer (in whose hands we believe that copies have been placed for examination) will soon also be evident. But it is only a few of their secrets that will be disclosed by the study of some months or years, and it will be for future generations to fully understand the value of the work which Dr. Roberts has undertaken. Dr. Roberts has himself foreseen this, and has felt it necessary that the photographs should be printed in permanent ink, for not only are the original glass negatives liable to be lost by accidental breakage, but he finds that, "after the lapse of a limited number of years the gelatine films will become discoloured, the images will fade, and the faint stars and the faint nebulosities will entirely disappear from view." This is a factor that should certainly be borne in mind by the directors of those observatories which are taking part in the work of international charting, for though the cost of reproduction of all the plates on paper print with permanent ink may be considerable, it is insignificant when compared with the cost of procuring the original negatives which may through lapse of time become valueless. Though we may be assured that in these photographs lie hidden the solution of many problems that have not been even stated as yet, the mere superficial investigation of one of these photographs seems to indicate many avenues for investigation. Four or five hours were spent in the study of one selected almost at random, and a few of the forms and configurations depicted in it were followed out. Cluster ☐ VI. 5 Orionis which is reproduced in Plate 2 is by no means one of the most striking photographs in the volume. It is no huge cluster, and no trace of nebulosity could be discovered. To the astronomical eye, however, its star images are objects of extreme beauty, being very small and perfectly round, the fainter stars looking like needle points of white on the dark background. In the s.f. corner of the Plate there is one of the most perfect spiral of stars that we have ever seen. No vestige of nebulosity is to be seen stretching in the spaces between the stars which curve through seven distinct widening convolutions round the large star which is evidently the central condensation of the original spiral nebula. The stars vary greatly in magnitude, large and small being intertwined in the convolutions without apparent law. From its appearance the stellar spiral is a left handed planar not a helical one, and its plane is not far from being perpendicular to the line of sight. The whole is like the sevenfold coil of a huge serpent covering some 20′ of arc in the sky. In the centre of the plate is another spiral of stars of a different species, and not of so distinct and perfect a nature. Here can be dimly made out a series of spirals which radiate from a common centre like the feelers of the cuttle fish. Following this central cluster by about 16 to 21 are two other clusters which Dr. Roberts says are suggestive of a spiral origin. A close examination indicates that these two clusters are not distinct but form part of the same helix of stars (which is a very perfect one). The apparent clustering seems due to the oblique presentation of the helix, which might be represented by three turns of a corkscrew. In this spiral the stars do not appear to present so great a range of magnitude as in the other two described. These three do not by any means exhaust the spiral forms which are to be found in this very wonderful photograph. In every region of the Plate are to be found spiral systems under some type or presentation. We heartily congratulate and thank Dr. Roberts for his issue of these beautiful and valuable photographs.

"Animals in Motion." An Electrophotographic Investigation of Consecutive Phases of Animal Progressive Movements. By Eadweard Muybridge. (Chapman and Hall.) 20s. net. Of all the results which have followed the introduction some quarter of a century ago of photographic methods into scientific research, the knowledge of animal locomotion which Mr. Muybridge has given to the world is certainly not the least important and interesting. Like many other investigators, Mr. Muybridge was put upon the track of his future elaborate experiments by a very simple incident. As he tells the reader in his preface, he was in the spring of 1872 directing the photographic surveys of the United States Government on the Pacific Coast, and being in San Francisco he took part in a controversy, the principal subject of which was the possibility of a horse while trotting—even at the height of its speed—having all four of his feet, during any portion of his stride, simultaneously free from contact with the ground. Mr. Muybridge resolved to attempt the settlement of the question, and though the days of the rapid dry photographic process had not yet come, he was soon at work with wet collodion plates. He commenced his investigation on the race-track at Sacramento in May of the same year, and in a few days made several negatives of a horse trotting literally in front of his camera at varying speeds; some of the resulting photographs exhibited the horse with all four of his feet clearly lifted, at the same time, above the surface of the ground. The next step was to obtain a series of photographs in rapid succession at properly regulated intervals of time, or distance, so as to discover the true explanation of animal movements. After designing special apparatus and utilising the leisure hours of a busy official career, Mr. Muybridge was able in 1878 to deposit at Washington Congress Library sheets of photographs illustrating consecutive phases of one complete stride of a horse, while walking, trotting, galloping, and so on. Then came the construction of the zoopraxiscope, an instrument for synthesising the actual image from these separate impressions. The discovery of celluloid ribbons, which made it possible to obtain a larger number of successive phases of motion, led the way to Edison's kinetoscope. But all these successes Mr. Muybridge regards as preliminary work to the production of his masterpiece of 1887, known as "Animal Locomotion" and containing more than 20,000 figures of moving men, women, children, beasts, and birds, in 781 photo-engravings, bound in eleven folio volumes. The possibility of taking the hundred thousand plates which were used in the preparation of this monumental work, and of publishing it, was due to the public spirited action of the University of Pennsylvania, which undertook the expense. The volume under consideration comprises a selection of the most important plates contained in the larger volume on a reduced scale, and should be in the hands of every student of science and art, since the plates furnish a trustworthy guide to the laws which control animal movements.

"A Book of Whales." By F. E. Beddard. Progressive Science Series. (Murray. 1900.) Illustrated. 6s. The huge bodily size of its more typical members, the few opportunities that landsmen have of seeing them, coupled with the fact that, in spite of their generally fish-like form, they are warm-blooded animals, surrounds the group of Whales, or cetaceans, with a halo of mystery and fascination which cannot fail to attract general interest. It is, therefore, most satisfactory to have a popular and succinct account of the group from a writer who has evidently worked hard at his subject and brought together almost all that is worth knowing concerning the structure and mode of life of these strange creatures. Taken as a whole, it may be said that Mr. Beddard's treatise is all that can be desired, and that it is likely to remain for a long time the standard popular work on the subject. To a certain extent it is more than this, for it enters on the consideration of many technical details, notably as regards the number of species, and the affinities of the various genera. Indeed, there may be a question whether the author has in all cases descended to the level of his readers, the use of terms like "thoracic musculature" when "muscles of the chest" would have served the purpose better, being calculated to mystify the uninitiated. Especially is this noticeable in the section devoted to osteology, where the ordinary reader is likely to be puzzled as to the exact meaning of terms like "acromion" and "coracoid process." And since figures of many bones are given, the difficulty could have been so easily avoided by the addition of descriptive letters. Confusion is also made by figuring in Plate IV. tympanic bones of the Right Whale and the Rorqual which belong to opposite sides. If we were disposed to be critical we could point out a good many typographical and grammatical blemishes; but in regard to errors of this description we will be content with asking our readers to compare the figure of Balæna australis facing page 22 with the cast in the Natural History Museum, from which it is taken, when we venture to affirm that a surprise will await them.

Among the more interesting features of Whales are the numerous "vestigial" structures to be met with, such as the functionless teeth of fœtal Rorquals, and the bony plates on certain Porpoises. That Cetaceans had toothed ancestors, everyone was prepared to admit, but that their progenitors should have been mail-clad animals is indeed a "staggerer." But it is very difficult to come to any other conclusion. And this leads to a puzzle, for the only mammals that are known to possess such an armour are the Armadillos and certain other Edentates, which are in no sense ancestral Cetaceans. Here, we regret to say, the author is not quite so clear as is desirable. While of opinion that both the Whalebone and the Toothed Whales have a common ancestry (p. 166), he seems undecided whether to regard such ancestry as connected with the Sirenia or the Ungulata. But if a dermal armour were present, it is quite certain that such ancestry had nothing to do with the sea cows, while it is difficult to see where the ungulate connection could have come in. Apparently Mr. Beddard will have nothing to do with a carnivorous ancestry for his favourites; although if this view were accepted the armour difficulty remains in full force.

An important feature in the work is the attention paid to fossil forms, and although the reference to these is for the most part satisfactory, exception may be taken by some to the statement that Whalebone Whales do not antedate the Miocene. Being in a charitable mood, we will assume that the statement on page 20 as to the derivation of Whales from Reptiles is a lapsus calami; but we must take exception to the one on page 220 that the Sabre-toothed Tigers were hindered by the conformation of their tusks from opening their mouths to the fullest extent!

In some parts, too, the author appears unnecessarily sceptical, as for instance when (p. 1?) he refuses to credit the statement that the Sperm Whale drops its lower jaw when feeding. Mr. Bullen's observations in the "Cruise of the 'Cachalot'" ought rather to have raised the question whether this animal can ever close its mouth when in the normal position. In refusing credence to the stories of Thresher Sharks attacking Whales, the author may have more justification on his side. In reference to minor errors, it may be added that the late Sir William Flower, and not Mr. Lydekker, is responsible for the statement that the Greenland Whale has only twelve ribs. It may also be mentioned that the names Pontoporia, Neomeris and Ziphius, used by Mr. Beddard, are all preoccupied.

"British Dragon Flies." By W. J. Lucas, B.A. (L. Upcott Gill.) 31s. 6d. Mr. Lucas has accomplished a very useful piece of work. Not only has he brought together into one volume information which hitherto was only to be found scattered through the journals of scientific societies and periodicals concerned with natural history, but he has by means of his handsome book drawn attention to a group of the Neuroptera which has been neglected in this country. Many reasons have conspired to bring about this neglect. The popular, though unfounded, dread of dragon-flies has had something to do with it. The comparative scarcity of the Odonata (the name under which the dragon-flies are known to the entomologist) is another cause tending to bring about the same result, while the obscure manner in which the early stages of these insects are passed has not helped their popularity with the ordinary collector. But dragon-flies will repay a careful study. The complete cycle of changes constituting their life-history is somewhat prolonged, it is true, but these animals are fascinating always, and indirectly of great use in the world. They are carnivorous and show no compunctions as to cannibalism. Of their beauty it is unnecessary to say anything; few people have failed to notice their graceful movements, rapid flight, and marvellous play of colours. Widespread as is the belief in their stinging powers, and accentuated as this superstition is as evidenced by their common name of "Horse-stingers," yet in reality they have no sting, and the very worst they can do is to inflict a slight bite which is almost painless. The insect's peculiar habit of curling the tip of its abdomen seems to be entirely responsible for the dread in which the rustic holds it. The volume is provided with twenty-seven beautifully coloured plates. The drawings of the larger species are given of the natural size, those of the smaller varieties being suitably magnified.

"Malay Magic: being an Introduction to the Folk-lore and Popular Religion of the Malay Peninsula." By W. W. Skeat. With a Preface by C. O. Blagden. 1900. (Macmillan.) 21s. net. It has been objected to the study of "Folk-lore" that it deals with fancies and myths rather than with serious "facts," and that it is therefore unworthy the attention of sober-minded men. But it may be hoped that such objections are now entertained only by the few; the majority admitting that from a psychological point of view such studies cannot but lay claim to a large share of interest, while occasionally they may be of great practical importance. As stated in the preface, "there can be no doubt that an understanding of the ideas and modes of thought of an alien people in a relatively low stage of civilisation facilitates very considerably the task of governing them." Every Anglo-Indian can recall instances where gross mistakes have been made by Government officials from want of touch with the feelings and prejudices of the people under their charge; and since the greater portion of the Malay Peninsula is now under British control, this alone affords a sufficient raison d'être for the work before us.

The author appears to have carried out a very laborious task with conscientiousness and thoroughness, and has at the same time succeeded in producing a highly entertaining and instructive volume. Among the various subjects treated of, we find legends connected with the creation of man and the world, ritual rites and magicians, spirits and demons, the various ceremonies connected with the chief epochs of human existence, together with dances, sports, games, theatrical exhibitions, and war and weapons. A series of photographic reproductions illustrate some of the more interesting of the objects and ceremonies described.

On this occasion we may confine our attention to a few of the myths connected with animals. Naturally, the elephant and the tiger loom large in Malay myth; and legends of ghost elephants ("gajah kramat") and ghost tigers ("rimau kramat") take the place of the "were-wolf" of European tradition. "Far away in the jungle," runs the myth, "the tiger folk, no less than the elephants, have a town of their own, where they live in houses, and act in every respect like human beings. In the town referred to their house-posts are made of the heart of the tree-nettle, and their roofs thatched with human hair, ... and there they live quietly enough until one of their periodical attacks of fierceness comes on and causes them to break bounds and range the forest for their chosen prey." Elsewhere, we find the origin of the tiger's stripes attributed to the chastisement inflicted on an unruly boy, who thereupon took the form of the great cat. The existence of the ghost-tiger, who is supposed to be invulnerable and to have one foot smaller than the rest, is a veritable reality to the Malays, who know the myth to be true, and act accordingly. When a wounded tiger escapes, it is believed to cure itself by eating a particular plant; and on the death of one of these marauders a special ceremony is held in honour of the body, which is propped up on all fours as if still alive, with the mouth kept wide open by means of a stick supporting the upper jaw. The ceremony, says the author, "was evidently regarded as a sort of 'reception' given by the people of the village to a live and powerful war-chief, a champion who had come to pay them a visit, the dancing and fencing which takes place on such occasions being intended for his entertainment."

Many other equally interesting extracts might be made did space permit, but we must refer the reader to the work itself, where he will scarcely fail to find much matter alike for amusement and for reflection.

"The Railways of England." Fifth Edition. By W. M. Ackworth. (Murray.) Illustrated. 10s. 6d. We are pleased to see a reprint of this useful work. Among the most wonderful innovations of the nineteenth century must be included that great spider's web of rails, spreading out in all directions over the land; and anyone who has not already attained a comprehensive acquaintance with our chief highways of communication will do well to secure a copy of Mr. Ackworth's book. Here some idea of the enormous strides effected by man's ingenuity since the year 1830, when the first public railway was opened in Lancashire, may be formed. Even during the past decade it is surprising to note what rapid transitions have taken place, rolling stock becoming to a great extent antiquated in so brief a period. The present edition has been put in touch with the latest developments, although the main features remain the same as in the first edition published ten years ago. All the leading railways are separately described, and, wherever possible, illustrations accompany the text. The picture of Waterloo Station as it appeared in 1848 forms an agreeable contrast with the present imposing structure; also the facsimile of a handbill announcing a four-days' journey to York in 1706 by means of a stage coach, and the same journey accomplished in three and a half hours in 1888 by railway, illustrate in a telling fashion the advantages of modern modes of travelling. We may add that the book is by no means technical in character, but, on the contrary, it is written in a clear and luminous style.

"Recent and Coming Eclipses." By Sir Norman Lockyer, K.C.B., F.R.S. Second Edition. Containing an account of the observations made at Viziadrug, India, in 1898, and of the conditions of the eclipses visible in 1900, 1901, and 1905. London: Macmillan & Co., Limited. 1900. Price 6s. net. The issue of the second edition of Sir Norman Lockyer's eclipse book is timely, just before the observers start on their several expeditions to see the eclipse of May 28th, 1900. In view of a third edition before the Sumatra eclipse, we would like to relate the comment of a doctor in India who read chapter II. on "Eclipse Work for Amateurs" before the 1898 eclipse with interest, and, after it, with sorrow tempered by indignation. "I should like to make Sir Norman Lockyer sit down to a microscope and draw in two minutes the essential features of a pathological specimen of liver unstained that he has never seen before. Then he might understand the feelings of a doctor who was lured into trying too many observations of the eclipse." Sir Norman Lockyer is certainly a past master in eclipse observation, but there is a serious defect in all his books which is also painfully apparent in this, that he himself seems to be both centre and circumference of the only field of research about which he cares to write. The gibing little rhyme written of him a third of a century ago, that he

"Thought himself owner
Of half the corona,"

seems to express but a moiety of the truth to-day. The book is a record of much good work, admirably planned and skilfully executed, nor is there any other single astronomer who could present an equal record of eclipse work from his own personal experience. But from the undue concentration upon his own theories and research the book is distinctly inadequate as a history of recent eclipse work. His recognition of other workers is extremely meagre. Thus in the eclipse of 1898 no reference at all is made to the observing party at Talni, although the spectra there obtained by Mr. Evershed were, in some respects at least, unequalled by any obtained elsewhere. The book is got up in the style which we are accustomed to connect with Sir Norman's other publications: the paper and print are good; the illustrations of a very inferior class.

"Anatomical Diagrams for the Use of Art Students." By James M. Dunlop, A.R.C.A. (George Bell & Sons.) An admirable and much needed work. The principles of action from the artistic point of view are expressed with absolute clearness. We commend it heartily to art students.

"The Norwegian North Polar Expedition, 1893-1896. Scientific Results." Volume I. Edited by Fridtjof Nansen. (Longmans.) Illustrated. 40s. net.

PRELIMINARY NOTICE.

The publication of the memoirs relating to the now famous "Fram" expedition will be eagerly welcomed by the scientific world. The first volume, a handsome quarto, very finely illustrated, is before us; it is to be followed by four or five of the same character.

The present volume contains memoirs on "The Jurassic Fauna of Cape Flora," by Dr. Pompeckj; the fossil plants from Franz Josef Land, by Dr. A. G. Nathorst; an account of the birds collected by Mr. Collet and Dr. Nansen; and the crustacea, by Mr. G. O. Sars.

The second volume will in all probability be taken up with the astronomical and magnetic results of the expedition. The monograph on the Celanography of the Polar Regions by Dr. Nansen is expected to appear in the third volume, together with "The depths and submarine features of the North Polar Regions," by the same author. The whole work will be completed in the course of about two years.

Our countrymen will be gratified to learn that the work is published in the English language only, which is regarded by the Editor as the most international tongue.

BOOKS RECEIVED.

Illustrated Annual of Microscopy—1900. (Percy Lund.)

Open Access in Public Libraries Exposed. By Edw. Foskett. (Curtis & Beamish.) 3d.

Calendar of the Science and Art Department—1900. 8½d.

Official Proceedings of the International Commercial Congress. (Philadelphia Commercial Museum.)

The Theory and Practice of Interpolation. By Herbert L. Rice. (The Nichols Press, Lynn, Mass.)

The Humane Review. April, 1900. (Bell.) 1s.

Practical Physics—Descriptive Catalogue of Apparatus. (Griffin.)

Francis Mary Buss Schools—Jubilee Magazine. April, 1900.

A Surgical Operating Table for the Horse. By Jno. A. W. Dollar. (Douglas.) 2s. 6d.

The Reliquary and Illustrated Archæologist. April. (Bemrose.) 2s. 6d.

Inorganic Evolution. By Sir Norman Lockyer. (Macmillan.) 4s.

Sexual Dimorphism in the Animal Kingdom. By J. T. Cunningham. (Black.) Illustrated. 12s. 6d. net.

A Treatise on Zoology. Edited by E. Ray Lankester, F.R.S. Part III.—The Echinoderma. (Black.) Illustrated. 15s. net.

Micro-Organisms and Fermentation. Third Edition. By Alfred Jorgensen. (Macmillan.) 10s. net.

Mental Culture. By George A. Hight. (Dent.) 3s. 6d. net.

Man and His Ancestor. By Chas. Morris. (Macmillan.) 5s.

The Struggle for Empire. By Robt. W. Cole. (Elliot Stock.)

Lessons in Elementary Physiology. New Edition. By Thomas H. Huxley. (Macmillan.) Illustrated. 4s. 6d.

Wireless Telegraphy and Hertzian Waves. By S. R. Bottone. (Whittaker.) 3s.

The Concise English Dictionary. New Edition. By Chas. Annandale. (Blackie.) 3s. 6d.

Smithsonian Institution—The Secretary's Report for the year ending June 30th, 1899.

The Studio. April, 1900. 1s.

WIRELESS TELEGRAPHY.—II.

By G. W. de Tunzelmann, B.Sc.

After the digressions made in the last article I will now ask my readers to return to the main subject of the present series, Hertzian Telegraphy, viz., a system of telegraphic communication by means of electric disturbances set up in, and transmitted from place to place through, the ether. The general outline of the subject contained in the earlier portion of the article referred to sufficiently indicates the simplest and most logical order of development of the subject to be the study, in the first place, of the medium in which the disturbances are excited, secondly, an inquiry into the nature of these disturbances; and here so little is definitely known that I can do little more than set forth hypotheses which would more or less fully explain the observed phenomena and which probably have a more or less distant resemblance to the actual facts; and, finally, an account of the apparatus and methods which have been employed in the winning of such knowledge as we have so far obtained, or which are now being employed in putting it to practical use.

THE ETHER

Sir Isaac Newton formulated a theory of light known as the corpuscular theory, according to which light was supposed to be due to very minute particles or corpuscles projected with enormous velocity from luminous bodies. Newton adopted this merely as a working hypothesis which gave a fairly reasonable explanation of what was known of light, but he was by no means satisfied with it. It accounted for the ordinary phenomena of reflection and refraction, but in order to account even for the simpler phenomena of polarised light it was necessary to make various more or less complicated additional assumptions. Still for a long time the corpuscular theory found a number of adherents to maintain it against the theory developed by Huyghens and others that light was a wave motion, the great objection to the acceptance of the undulatory theory being the necessity of assuming the existence of a medium filling the whole space occupied by the visible universe and having properties of a character hitherto quite unfamiliar. It was not until it became possible to make comparative measurements of the velocity of light in media of varying density that the corpuscular theory was definitely overthrown, since it demanded that the speed of transmission of light should increase with the density of the medium, whereas it is found that it decreases as the density increases, as is required by the wave theory. Since then new phenomena have been predicted from the wave theory and experimentally verified, and the whole theory of spectrum analysis rests upon it, so that it, and therefore the existence of the luminiferous ether, is no longer regarded as a working hypothesis but as a fact, the evidence in its favour being quite as strong as that for the truth of Newton's law of Universal Gravitation.

At the present time we not only know that light and radiant heat are due to etheric vibrations but we know the exact nature of the vibrations, and as regards light we know the lengths of the waves corresponding to the various colours of the spectrum. We know, too, that heat waves are exactly similar to light waves except that they are of greater length, and the only reason that we cannot make measurements of heat waves with the same degree of accuracy as of light waves is that we have no special organ for the heat sense corresponding to the eye, which forms an instrument of extreme sensitiveness for light observations.

Sound waves are transmitted by ordinary matter, either solid, liquid or gaseous, and, as is well known, sound cannot be transmitted through a space which does not contain matter of very sensible density, a comparatively thin stratum of even such an imperfect vacuum as can be obtained by the aid of a good ordinary air-pump being sufficient to entirely stop it. When sound travels through a solid mass of matter the vibration takes place in all possible directions, but when it is transmitted through fluid, whether liquid or gaseous, the vibrations are entirely longitudinal, that is to say the motion of the moving particles is always parallel to the direction in which the sound is travelling. The reason of this is that while fluids possess volume elasticity, or resistance to change of volume, they have no rigidity, or resistance to change of shape, and substances without rigidity can only transmit longitudinal vibrations, the transverse vibrations being entirely due to resistance to shearing, that is, to the sliding of one portion of the substance over another.

It has long been known from the phenomena of light that the vibrations are entirely transverse, that is to say, any particle of the vibrating medium remains throughout its motion always in the plane perpendicular to the direction of transmission of the ray of light, the longitudinal vibrations being non-existent. No explanation of this suppression of the longitudinal vibrations was obtained until Maxwell showed theoretically that this was characteristic of electro-magnetic waves, and suggested the probability of light waves being simply electro-magnetic waves having wave lengths between the limits within which the human eye was capable of responding to them.

Between fifty and sixty years ago that great philosopher and experimentalist, Michael Faraday, seems to have had some kind or instinctive glimmering of an idea that there was some connection between electricity and light. In the then state of knowledge there was nothing apparently to warrant it, but he tried a number of experiments upon the effects of electric and magnetic fields upon rays of light before he obtained any result.

He allowed a beam of plane polarised light to pass through holes in the poles of a powerful electro-magnet, so that the direction of transmission of the ray was parallel to the lines of force of the magnetic field. A very dense kind of glass containing borate of lead, a glass which Faraday had himself discovered and made some years before, was then placed between the poles, when it was found that if an analyser was so arranged as to stop all the light before the magnet was excited, then on excitation taking place there was a slight brightening of the field which could be reduced to darkness again by slightly rotating the analyser.

Neither Faraday nor anyone else was able at the time to account for a fact obtained through the coincidence of a number of circumstances all requisite for success, though not one of them could have been predicted, and which furnishes a wonderful example of the thoroughness and utter disregard of repeated failures which was one of the leading characteristics of Faraday's experimental work.

The meaning of this experiment was first pointed out by Sir William Thomson, now Lord Kelvin, and its important consequences were fully investigated by Maxwell, who in all probability was led by it to formulate his electro-magnetic theory of light.

I have already pointed out that the vibrations forming a ray of light are all in a plane perpendicular to the direction of the ray. In general the vibrations take place in all possible directions in this plane, but it is possible by allowing a beam of light to pass through certain crystals, and by other means, to break up these vibrations in all possible directions in the plane into vibrations in two directions at right angles to each other, and it is further possible by simple means to get rid of one set of vibrations, leaving only vibrations which are all perpendicular to a plane containing the ray and which is known as the plane of polarisation, the light being said to be plane polarised.

Faraday's discovery was that it was possible by means of a magnetic field to produce rotation of the plane of polarisation.

Maxwell called attention to the fact that the observed velocity of light was, within the limits of errors of observation, identical with the rate of propagation of an electro-magnetic disturbance deduced theoretically from certain electrical measurements, and cited other experimental facts in its favour; and many other facts since discovered have confirmed Maxwell's conclusions, more particularly the work of Hertz, which I shall consider later in some detail, and in which he demonstrated experimentally that electro-magnetically excited waves could be made to interfere with each other and could be reflected and refracted exactly like light waves.

Heat and light are therefore found to be mere special cases of electro-magnetic waves which may vary through all gradations of wave lengths varying from thousands of miles down at any rate to a few hundred thousandths of an inch in the case of light waves, and the great electro-magnetic spectrum extends, we know, far beyond this, for we can detect by their effect on photographic chemicals the existence of waves far beyond the violet end of the spectrum, that is to say of waves shorter than the shortest light waves which the eye can perceive.

Lord Kelvin, in a paper published in the "Transactions of the Royal Society of Edinburgh" in May, 1854, has shown how a probable minimum limit may be assigned to the density of the ether.

The French physicist, Pouillet, as the result of a series of carefully-made measurements, had found that the heating effect of direct sunlight fallng on a surface of a square centimetre at the distance of the earth from the sun amounted to 1.7633 gramme Centigrade units of heat per minute, or 1.234×10^6 ergs per second. This would evidently be the amount of energy due to sunlight contained in a prism with a base having an area of a square centimetre and with a height equal to the velocity of light in centimetres per second, viz., 3.004×10^{10}, which gives as the energy per cubic centimetre per second:

$$\frac{1.234 \times 10^6}{3.004 \times 10^{10}} = 4.1 \times 10^{-5} \text{ ergs.}$$

Lord Kelvin deduces from this datum a superior limit to the velocity of a vibrating particle of the medium transmitting radiant heat or light, on the assumption that the amplitude of vibration is a small fraction of the wave length and that the maximum velocity of a vibrating particle is small compared with the speed of propagation of waves. The first assumption is certainly justifiable, and the second follows from it, for considering the case of plane polarised light where the vibration is a simple harmonic one, if V be the velocity of wave transmission, v the maximum velocity of a vibrating particle, A the semi-amplitude or distance of the vibrating particle at the extremity of an excursion from the position of equilibrium, and λ the wave length, then it is known that

$$\frac{v}{V} = 2\pi\frac{A}{\lambda}$$

Now the whole mechanical energy of homogeneous plane polarised light in an infinitely small space containing only particles sensibly in the same plane of vibration is entirely potential when the particles are at rest at either end of an excursion, entirely kinetic when the particles are in the position of equilibrium, and partly potential and partly kinetic in all other cases.

This energy being constant in amount is equal to $\frac{1}{2}mv^2$, where m is the mass in vibration, for v is a maximum in the position of equilibrium. If, therefore, ρ is the mass of vibrating matter in unit volume, or, in other words, the density of the matter, the mechanical value of the energy is $\frac{1}{2}\rho v^2$.

In the case of circularly polarised light, in which every particle describes a circle with constant velocity, the energy is half potential and half kinetic, so that if v is the constant velocity the energy is ρv^2.

In the case of elliptically polarised light, the value lies between the two. Moreover, for co-existent series of waves of different periods polarised in the same plane, the mechanical energy is the sum of the portions due to each, from which it follows that the maximum velocity is the sum of the separate velocities.

The same reasoning applies to circularly polarised light of different periods. It follows, therefore, that the mechanical energy must certainly be less than the product of half the mass into the square of the maximum velocity acquired by a particle in the case of plane polarised waves, and it may be concluded that for any radiation, unless homogeneously circularly polarised, the mechanical value of the disturbance is less than the product of the mass into the maximum velocity of a vibrating particle.

That is to say, 4.1×10^{-5} ergs is less than ρv^2, and therefore very much less than ρV^2, or ρ is certainly very much greater than $\frac{4.1 \times 10^{-5}}{(3.0004)^2 \times 10^{20}}$.

If we assume $V = 100\,v$, which is a reasonable one to make, then ρ comes out as somewhere about $\frac{4}{9} \times 10^{-21}$. Now the ratio of rigidity to density is equal to the square of the speed of transmission, which gives for the rigidity $\frac{4}{9} \times 10^{-21} \times 9 \times 10^{20}$, or about $\frac{2}{5}$. This is small compared to the density of any known solid. Steel is the most rigid substance known to us, and its rigidity is as high as 8×10^{11}.

It is not only in free space that luminous and other electrical vibrations are transmitted by ether. Water and other fluids, for example, transmit light, but it cannot be the fluid which acts as the medium, for it has no rigidity, and is therefore incapable of transmitting transverse vibrations. Even in transparent solids the waves must be transmitted by ether penetrating the interstices of the matter composing them, for the rate of transmission is far too great for the matter itself to be the medium.

The ether, however, within different kinds of matter is largely modified to an extent depending on the substance. For example, in heavy glass the speed of transmission of a luminous wave is only about two-thirds of the speed in free space. The ether must, therefore, either have its density increased or its rigidity diminished by the presence of the particles of glass.

Many considerations appear to me to favour the latter hypothesis in preference to the former one. If the ether is capable of having its density varied it must be compressible, and therefore its structure must be molecular, and these molecules must be elastic, and then if we are to adhere to our plan of assuming that every action between distant bodies is due to actual pushing or pulling of bodies actually in contact with them, we shall require a second ether to explain the elasticity of the molecules of the first.

We therefore seem to be driven to the conclusion that the ether is to be regarded as continuous and therefore incompressible, so that the modification of ether in contact with matter must consist in a diminution of rigidity and not in an increase of density.

This conclusion appears to me to be strongly confirmed by the simple explanation which it gives of opacity. There is no such thing as a perfectly opaque body, but some come very near it, and on our theory, which is practically that of McCullagh, the explanation is that in such bodies the rigidity of the ether approaches the vanishing point. If we adopted Fresnel's theory of the increase of density of ether in contact with matter we should have to suppose the density of the ether in practically opaque bodies to be increased to an enormous extent.

Another point in favour of this view is that if we assume with McCullagh that the diminution in rigidity is due to a sort of straining of the ether towards the particles of matter we get at something like the explanation of gravitation, for under those circumstances two bodies would tend to draw together. Objectors to the ether on the ground of the complication involved in the co-existence of two apparently so distinct things as matter and ether may be interested to learn that Lord Kelvin has suggested a simplification of a very beautiful character.

While fluids at rest have no rigidity, portions of them may become rigid by being set in rapid motion, as is well illustrated by the smoke rings which some smokers are very skilful in blowing from their mouths and which may easily be produced in air, water, and other fluids.

Lord Kelvin made the beautiful suggestion that the apparently unchangeable atoms of different kinds might simply be vortex rings of various shapes in the ether, which from this point of view must act as a perfect fluid.

Errata to last Article, p. 25, column 2, line 26, read "this medium is *relatively to its density* far more rigid than steel"; p. 26, column 2, line 13, for "electric bodies" read "electric waves."

DROPS AND THEIR SPLASHES.

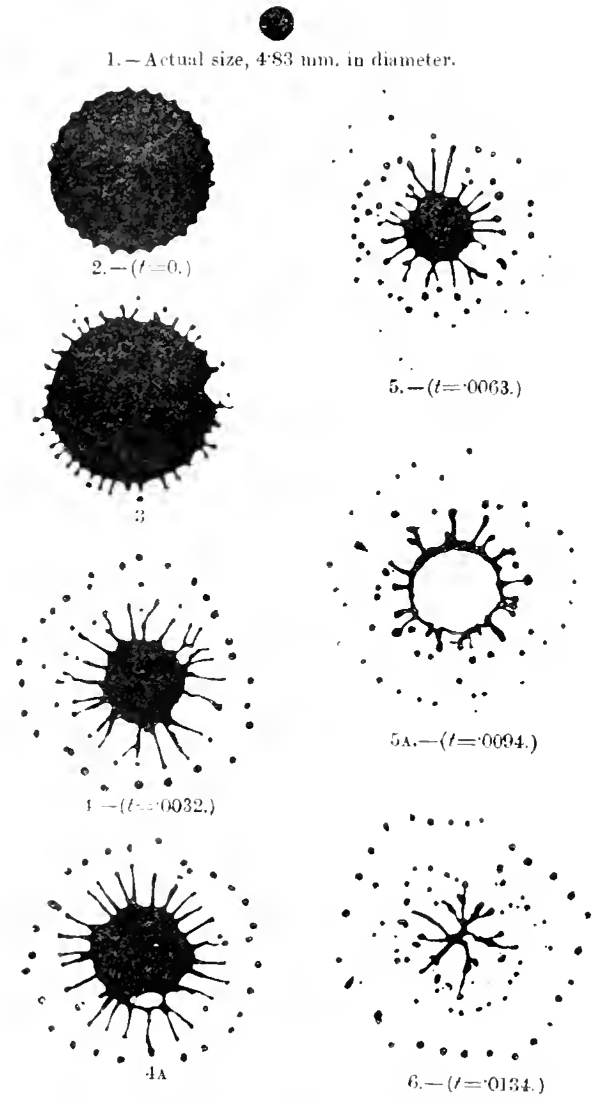
THE beauty and scientific meaning of familiar phenomena cannot be gauged by popular views regarding them. It would be difficult to imagine anything more commonplace to the ordinary observer than the splash of a drop, yet Professor A. M. Worthington's researches, extending over many years as they have done, and the first series of which were but recently completed, show that this apparently simple occurrence, when examined by the refined methods which science makes possible, is really a succession of bewilderingly beautiful phases, which for their complete interpretation require the resources of higher mathematical analysis. The same distinguished investigator has demonstrated that a variety of allied phenomena, while fundamentally dependent upon the same properties of matter, are all characterized by their individual peculiarities of changing forms, which can be reproduced at will by the experimenter.

It is not necessary in this place to trace the development of the perfected form of apparatus used in the most recent experiments, for the steps by which the final disposition of the instruments was reached may be followed in the "Proceedings" and "Philosophical Transactions of the Royal Society." The essence of the problem which Prof. Worthington had to solve can be very briefly stated. How could a drop of definite size be allowed to fall from a known height in comparative darkness upon a surface, and be illuminated by a flash of exceedingly short duration at any desired instant, at any particular stage of the impact of the drop, so as to exclude all other stages previous and subsequent to the one picked out? More than this, if necessary the experiment must be capable of repetition, with an exactly similar drop falling from exactly the same height, and illuminated at exactly the same stage. It must then be possible, after this particular stage has been sufficiently examined, to be able to arrange that a later stage, say one-thousandth of a second after the other, may be studied in the same manner as the earlier one, and in this way to follow step by step the course of the whole series of changes.

In his early observations, as no photographic plates were then available sufficiently sensitive to respond to the very short exposures that were required, Prof. Worthington had perforce to study the different stages by eye and make drawings of them. Though he was enabled by this means to trace with marvellous accuracy the complete splash, yet the application of the photographic method in more recent years has made it possible to confirm, to extend, and in some cases correct, the results of ocular observations. Following Prof. Boys' suggestion, who had in his popular flying bullet experiments used sensitive plates, Prof. Worthington and his colleague, Mr. R. S. Cole, employed Thomas's cyclist plates, with excellent results. To give an idea of the results of an extended series of experiments on splashes of a great many kinds, which have all been photographed and examined in the same systematic way, it will be best to select two typical instances for description. The two cases chosen, which are shown graphically in the accompanying illustrations, are, first, the splash of a drop of mercury 4.83 millimetres in diameter falling through fifteen centimetres upon a plate of glass; and second, of a large stone sphere 3.2 centimetres in diameter, falling through a height of 14 centimetres into water mixed with milk, contained in a glass bowl about one foot deep and nine inches in diameter.

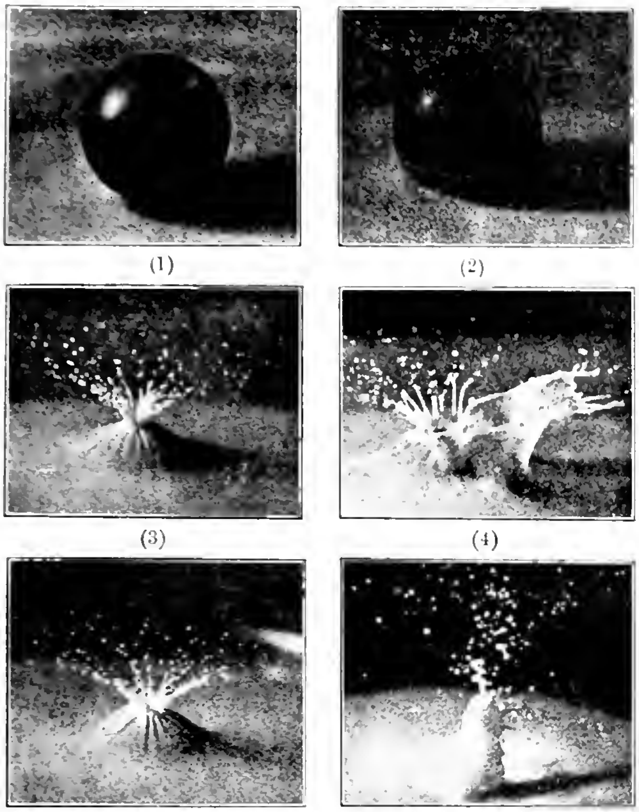
The first set of pictures were obtained by allowing the drop of mercury to fall upon the naked photographic plate itself. The illuminating spark was produced vertically above the plate, and consequently the figures only show a horizontal section of the drop in various stages. Very soon after the first instant of impact minute rays are shot out in all directions. These are afterwards united, and then main rays shoot out (see Fig. 3), from the ends of which, in some cases, minute droplets of liquid split off, to be left lying in a circle on the plate and visible in all subsequent stages. Figs. 4, 4A and 5 show how the central mass contracts but leaves long arms or rays which contract more slowly. In Fig. 5A the thin film has torn open in the middle and yielded an annulus, which in turn would separate into a ring of drops surrounded by a second circle of the still smaller and more numerous droplets that split off the ends of the rays. It must be remembered that the interval of time during which all the stages shown in the figure are passed through is very small, being, as the numbers indicated show, only about the one-seventy-fifth part of a second.

Before referring to the second series of photographs it is necessary to point out that the form of the splash in this case depends very much upon the condition of the surface of the sphere. When a polished sphere of marble, rubbed very dry with a cloth just beforehand, is dropped into water, the water spreads over the sphere so rapidly that it is sheathed with the liquid even before it has passed below the general level of the surface. The splash is insignificantly small and of short duration. But if the sphere be roughened with sand-paper or left wet, the water is driven away laterally, forming a ribbed basket-shaped hollow, which, however, is now prolonged to a great depth, the drop being followed by a cone of air, while the water seems to find great difficulty in wetting the surface of the sphere completely. The first photograph shows a highly polished sphere just before the impact with the liquid. The beginning of the rise of the sheath can easily be made out in the second



Instantaneous Shadow Photographs (life size) of the Splash of a Drop of Mercury falling 15 cm. on to Glass.

photograph, while the want of symmetry in the fourth stage depicted is due to the sphere having been rough on the right side and polished on the left. This photograph shows at a glance the great difference between a "rough" and a "smooth" splash. The puckering of the surface, which is strongly marked in the fifth photograph, indicates that the lines of flow near the surface of the liquid when once determined are very persistent. The general surface of the milk-and-water in the next stage is very level, while the volume of the column which can be very clearly seen is scarcely more than one-tenth that of the sphere. This proves that there is an instantaneous general rise of level even at a great distance. The interval of time between the instant of impact and the form of the splash shown in the fifth photograph when the sphere is completely covered was a little under one-seventy-fourth of a second.



(5) (6)

Splash produced by a polished stone ball, 3·2 cm. in diameter, when falling into a basin of milk and water, from a height of 14 cm. Starting from the instant at which the sphere touched the surface of the liquid, the intervals of time that have elapsed, in fractions of a second, are as follows:—

(1) t = 0. The ball has just reached the liquid.
(2) t = ·0025 sec. Sheath of liquid beginning to rise.
(3) t = ·0080 sec. Ball already covered.
(4) t = ·0110 sec. Shows the effect of polishing the left side only, leaving the right side rough.
(5) t = ·0134 sec. Regularity restored by complete polishing.
(6) t = ·0242 sec. Column resulting from converging streams of liquid.

The mechanics of the phenomena to which special attention has been thus briefly referred is a subject of too abstruse a nature to be gone into here, but the interested reader who wishes to become more intimately acquainted with these particularly interesting researches should make a point of studying the papers under Prof. Worthington's name in the Royal Society's "Proceedings" and "Transactions." The illustrations here reproduced show that the commonest occurrences may be made fruitful subjects of scientific analysis.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

Dr. H. C. Sorby, F.R.S., contributes to the current issue of the *Journal of the Royal Microscopical Society* a paper on "The Preparation of Marine Worms as Microscopical Objects." With a view to preserving the minute blood vessels of *Nereis* from decomposition, the author experimented with many reagents, but rejected all of them in favour of glycerine. His method is, briefly, as follows:—Specimens measuring from two to three inches in length were killed by placing them in strong glycerine diluted with an equal volume of water, and were afterwards immersed in fresh water for ten minutes to eliminate the glycerine. They were then arranged on a microscope slide, and dried quickly in the open air at the ordinary temperature. A cell built of glass slips was attached to a slide, and the specimens were mounted in balsam and protected by a thin cover glass in the usual way. Dr. Sorby has specimens that were treated thus two years ago, and they not only show no signs of change, but the structure of the animal is more clearly defined in the preserved state than it is when the animal is alive or recently dead.

At a demonstration recently given before the Royal Microscopical Society of London, Dr. Spitta exhibited some very fine micro-photographic work which he had done with lenses by Zeiss, Powell, Beck, and Wray. He spoke very highly of the one-eighth apochromatic N.A. 1·40 by Zeiss, which he considers to be "the finest lens in the world" for micro-photography.

Mr. W. Colquhon has been experimenting with staining processes for the purpose of differentiating the canaliculi in bone. None of the usual methods gave satisfactory results, for though the nuclei of the bone corpuscles were stained, the outlines of the canaliculi were only faintly shown. Glass tubing was, therefore, arranged in lengths of twelve feet on a wall, and a bone with the head sawn off, the medullary cavity cleaned out and one end corked, was connected with the glass tube by means of a wide rubber tube. The periosteum was removed, and any holes visible on the outside were plugged with wooden pegs. The tubing was then filled the whole length with stain, to which a little antiseptic had been added. The bone being in a dry room, dried, and as this occurred the stain was drawn in to take the place of the evaporated moisture. After about a month all of the nuclei of the bone cells were found stained, and also the lining membranes of the canals. The bone matrix remained unstained, but the canaliculi were faintly outlined.

The new section of "Laboratory Photography," which has recently been included in the *Journal of Applied Microscopy*, is both interesting and useful. Among many articles bearing on the methods and technique of microscopy is a suggestive paper on "Practicable Photo-micrography," by Mr. C. Potter, and a note by Mr. W. E. Britton on "The Ray Filter in Laboratory Photography."

An electric microscope lamp has recently been placed on the market by Messrs. J. Swift & Son. It was designed by Mr. J. E. Barnard to give an evenly illuminated field in the microscope, without the image of the filament of the incandescent lamp being thrown up from the mirror in the field of view. This is effected by a light from the incandescent filament falling upon a flat plane placed at an angle of 45° to the axis of the lamp, and the surface of which is covered with a preparation which throws off an intensely white light in such volume that the largest mirror of any microscope can be fully illuminated. The lamp is mounted on a swivel, enabling it to be placed at any angle, and can also be lowered or raised at will.

The focussing of a microscopic object on a ground glass screen requires much skill and care. The screen which is supplied with the ordinary camera is generally too coarse, and in high power photo-micrography even the finest ground glass obtainable does not always give satisfactory results. For critical and medium work it is essential that the focussing screen should be, as far as possible, without grain. A simple way of preparing such a screen is as follows:—Take an unexposed photographic dry plate and immerse it in a solution of chloride of barium for ten minutes. Transfer it to a bath of dilute sulphuric acid and gently rock the solution to and fro until a fine, even precipitate of barium sulphate has been deposited. Wash and dry the plate, and it will be ready for use.

Another method, recommended by Prof. Gage and others, is to find the centre of the ground glass screen and then to place a large circular or square cover-glass on it with Canada balsam. To do this, warm the ground glass carefully, add a drop of rather thick balsam to the centre on the ground side, and then apply the cover and press it down firmly. Put it away on a warm shelf for a few days to harden, after which the excess of balsam may be removed from the edges with the aid of a penknife and xylen or alcohol. The balsam will fill up the inequalities in the glass, and being of about the same refractive power will make this part of the glass clear as if it were unground. The focussing screen as thus prepared with a clear centre, serves both for the general focussing and the finest focussing, and avoids the danger of using the double screen.

For the photography of opaque substances, such as metals, &c., a metal microscope, such as that which is made by Reichert, of Vienna, is necessary. The microscope must be fixed in an upright position, and reflected light used. The source of light should be at a distance of one to one and a half metres from the apparatus, and must be on the same level as the reflecting lens at the side of the vertical illuminator on the tube of the microscope. The specimen should be everywhere equally illuminated and then focussed. Eosin plates and the use of a yellow screen are to be recommended for this work.

The selection of plates and screens for photo-micrography is a subject upon which we propose to say more in future issues. The following points are of practical importance, and should receive careful attention :—For stained preparations orthochromatic plates give the best results, but it is of advantage to place a screen, complementary in colour to the stain used, between the source of light and the microscope. Generally speaking, a light filter of picric acid should be used for specimens stained dark red, or violet; for light red stains, a greenish-yellow one; and for preparations stained with methylene blue, a dark orange-yellow filter is recommended.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* Knowledge.]

NOTES ON COMETS AND METEORS.

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

The Discovery of Comets.—In the century from 1700 to 1799 inclusive 64 comets were discovered and observed sufficiently well for their orbits to be computed. The average rate of discovery was therefore 0.64 annually or about two comets every three years. A vast increase in the number of these discoveries is shown by the figures for the century from 1800 to 1899. 315 comets were found, including redetections of periodical comets, so that the annual average was 3.15. Comparing the first with the last half of the century the numbers were—

	Comets found.	Annual average.
1800 to 1849 ...	.. 91 ...	... 1.8
1850 to 1899 ...	... 224 ...	... 4.5

There were comparatively few comets found before 1840, but in that year and the few ensuing ones a marked rise occurred, and observers have been very successful in this field ever since. The numbers of comets discovered in the various months of the year during the period 1800-1899 were as follows :-

January ...	. 17	July ...	... 35
February .	. . 19	August	. 40
March	. . 24	September	25
April	... 27	October	. 26
May	.. 20	November	31
June	.. 28	December	. 25

Of the spring months March and April show the best returns. In the summer there is a rapid rise from June to August, the latter being apparently the best month of the year for sighting new comets. In the autumn, November has a good record, notwithstanding the unfavourable weather often prevailing at this period.

Giacobini's Comet.—During the coming summer cometary observers will have an interesting object for study though it will be by no means bright. It will, however, occupy an extremely favourable position in the sky during the four months June to August inclusive. At the end of May the comet will become visible in the morning sky, being placed in the N.E. extremity of Pisces and about 7 degrees south of Beta Andromedæ. Thence it moves to the north-west, and early in July will be found in the left hand of Andromeda, near Nu, Chi, Psi, and Lambda in that constellation. It afterwards traverses Lacerta and Cygnus, passing near Alpha, and at the end of July will be about 2 degrees south of Delta. Passing then through Lyra it enters the eastern borders of Hercules, and will be near Alpha Ophiuchi at the middle of September. But its great increase of distance will now have rendered it faint, and its motion south will carry it out of sight altogether. Our last number contained an outline ephemeris by Berberich, and it is intended to give its path with more detail so that the object may be attentively followed during ensuing months.

Stationary Radiation of Meteors.—This may be said to form one of the moot points of astronomy. It is not a discordance between rival observers, but a difficulty of explaining observed facts on approved mathematical theories. In 1878, when fixed or recurring radiants were brought prominently into notice, it was asserted that they must be due to successive but different showers accidentally grouped in such a manner as to render their apparent directions almost identical. But ob ervation showed that this idea did not satisfactorily account for the facts because the points of divergence remained constant (allowing for small and unavoidable errors of observation), and that there were no such differences as a mere chance grouping of streams must certainly occasion. Wherever a radiant is placed relatively to a neighbouring star there it remains during the whole period of its visible activity, and this often covers several months. Of late several able mathematicians have attacked the matter, and valuable papers have appeared from Profs. A. S. Herschel, H. H. Turner, and G. von Niessl, Dr. Bredikhine, and M. O. Callandreau. Prof. Turner has offered a very ingenious explanation of stationary radiation ("Monthly Notices," Jan., 1899), on the basis of planetary perturbation operating through vast intervals of time upon meteoric particles, and the observed peculiarity seems in a fair way of being understood. More observations would be very valuable. Very few astronomers have ever practically investigated the matter, for the reason that it requires a vast number of very accurate materials before any satisfactory tests can be applied as to the stationary aspect of the minor showers generally. Instead of examining the whole question it would be better to select a test case, say that supplied by the Orionids of October. If this notable autumn shower were attentively watched between October 12 and 25 and the radiant independently determined on each night it would be easily seen whether the radiant were stationary. And if one well known shower is found perfectly stationary during a fortnight there can be no reason why other showers may not present a similar aspect during even longer intervals.

May Meteors.—The spring season may be described as one of meteoric scarcity. The Aquarids, sometimes visible in the morning twilight, and possibly associated with Halley's comet, furnish, however, an interesting system which well deserves looking for. It furnishes fine long meteors with streaks during the first week in May, but they are only perceptible just before daylight as the radiant is below the horizon in the early part of the night.

Fireball, March 28th, 8h. 31m.—A large meteor giving two outbursts like vivid lightning flashes was seen by Mr. G. T. Davis at Reading. He says it passed from near Cor Caroli towards Denebola, but described a curve ending near Epsilon Virginis. It exploded twice, finally breaking up into sparks. The meteor lit the place up. Mr. T. H. Astbury, of Wallingford, writes that he was looking north at the time, and only saw the brilliant flashes of light which the meteor occasioned. From inquiry afterwards he found that the meteor's apparent path was from about 188°+18° to 193°−6°, and that it was very much brighter than the planet Venus.

THE FACE OF THE SKY FOR MAY.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 4.33 and sets at 7.21; on the 31st he rises at 3.51 and sets at 8.3. One of the most striking astronomical events of the year will be the eclipse of the sun on the 28th. Full particulars as to the parts of the earth's surface from which the total phase will be visible are given by Mr. Maunder in the March number of Knowledge. Over the British Islands a large partial eclipse will be visible, the data given in the *Nautical Almanac* being as follows :—

Place.	Magnitude.	Begins.	Angle from North.	Angle from Vertex.	Greatest Phase.	Ends.	Angle from North.	Angle from Vertex.
			°	°			°	°
Greenwich	0.681	2.47	108 W.	146 W.	3.55	4.58	111 E.	69 E.
Cambridge	0.664	2.47	109 W.	146 W.	3.54	4.56	112 E.	70 E.
Oxford	0.683	2.45	108 W.	145 W.	3.54	4.57	111 E.	69 E.
Liverpool	0.656	2.42	110 W.	143 W.	3.50	4.53	112 E.	72 E.
Edinburgh	0.599	2.41	114 W.	144 W.	3.46	4.47	115 E.	78 E.
Dublin	0.676	2.38	109 W.	141 W.	3.47	4.52	111 E.	71 E.

All the times above are expressed in Greenwich Mean Time, and are P.M.; the position angles of the contacts are for direct image.

Three phases of the eclipse at Greenwich are illustrated in the accompanying diagram, which is constructed with the vertex at the top in each case.

ECLIPSE OF THE SUN, MAY 28TH, 1900, as it will appear in London

3 P.M. 3.55 P.M. 4.45 P.M.

Eclipse begins, 2.47 P.M. Eclipse ends, 4.57 P.M.

THE MOON will enter first quarter on the 6th at 1.39 P.M.; will be full on the 14th at 3.37 P.M.; will enter last quarter on the 21st at 8.31 P.M.; and will be new on the 28th at 2.50 P.M. The solar eclipse on the 28th will furnish a good opportunity of observing the Moon's limb.

The principal occultations during the month are as follows:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
May 1	ι Tauri	4·7	8.58 P.M.	110	71	9.18 P.M.	259	224	2 16
„ 5	A' Cancri	5·6	11.48 P.M.	124	84	12.42	277	240	6 19
„ 6	ω Leonis	5·6	11.1 P.M.	79	40	11.51 P.M.	329	290	7 18
„ 7	19 Sextantis	6·0	10.43 P.M.	127	93	11.49 P.M.	285	247	8 18
„ 19	B.A.C. 6707	6·2	12.39 A.M.	22	49	1.18 A.M.	315	337	19 20

THE PLANETS.—Mercury is a morning star until the 30th, when he is in superior conjunction. He is not well placed for observation in our latitudes. He will be very close to the sun during the total eclipse on the 28th.

Venus remains an evening star throughout the month, and will reach her greatest brilliancy at the end. The apparent diameter will increase from 24"·2 on the 1st to 36"·4 on the 31st, and on the 15th the illuminated portion of the disc will be 0·402. The path of the planet is easterly through Gemini. The planet will be near to Epsilon Geminorum on the 14th and 15th, about $1\frac{1}{2}°$ to the north, and a little over 3° to the north of Delta on the 27th.

Mars is a morning star, not well placed for observation.

Jupiter will be in opposition on the 27th. On the 1st he rises about 9.45 P.M., and crosses the meridian shortly before 2 A.M. On the 31st he rises at 7.31 P.M., and crosses the meridian at 11.39 P.M. The apparent diameter is 41" on the 1st, and 42" on the 31st. On account of his southerly declination of nearly 21°, the planet only reaches a low altitude, even when on the meridian. The path is a westerly one, a few degrees north of Antares. The satellite phenomena are most interesting on the 3rd, 7th, 10th, 16th, 17th, 18th, 19th, 23rd, 26th and 27th.

Saturn rises shortly before midnight on the 1st, and a little before 10 P.M. on the 31st. The planet describes a short westerly arc a little north of Lambda Sagittarii. The apparent polar diameter increases from 16"·2 to 16"·8 during the month; the ring is widely open, and its northern surface is presented to us.

Uranus rises about 10 P.M. at the beginning, and about 8 P.M. at the end of the month. The planet traverses a short westerly path, about $2\frac{1}{2}°$ east of Jupiter, on the 1st, and about 5° east on the 31st.

Neptune sets about 11 P.M. on the 1st, and a few minutes after 9 P.M. on the 31st. He is nearly midway between Zeta Tauri and 132 Tauri.

THE STARS.—About 10 P.M., at the middle of the month, Spica Virginis will be due south, Arcturus a little east of south, Ursa Major nearly overhead, Scorpio rising in the south-east, Vega pretty high up in the east, Cygnus north-east, Leo in the south-west, and Gemini a little north of west.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of April Problems.

No. 1.

(W. Gleave.)

1. Kt (Q5) to K3, and mates next move.

No. 2.

(H. A. Wood.)

1. R to QB5, and mates next move.

CORRECT SOLUTIONS of both problems received from W. Nash, Alpha, G. A. Forde (Capt.), H. S. Brandreth, W. de P. Crousaz, K. W., J. W. Meyjes, J. Baddeley, H. Le Jeune. Of No. 2 only, from W. A. Rogerson.

B. G. LAWS.—Many thanks for your three-mover. It is marked to appear in the June number.

K. W.—Mr. Rayner's book is entitled "Chess Problems, their Composition and Solution." Price 1s. The publishers are Messrs. Swan Sonnenschein & Co., Paternoster Square, E.C. I am indebted for this information to Mr. B. G. Laws, the author of "The Two-move Chess Problem."

W. PARKINSON.—If (No. 1) Q × B, R moves, there is no mate at QB2, as the Pawn can cover. In No. 2, 1. Q to Q7 is answered by P to K7 or other equally good defences.

W. A. ROGERSON.—Q × Kt very nearly solves No. 1, but 1 . . . R to B3 just prevents it, as Kt × R is not mate. Your notation is quite correct.

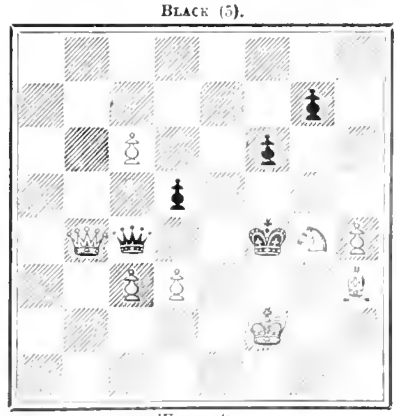
H. D. DRYERRE, Junr.—See reply above.

PROBLEMS.

No. 1.

By N. M. Gibbins (Repton).

BLACK (5).



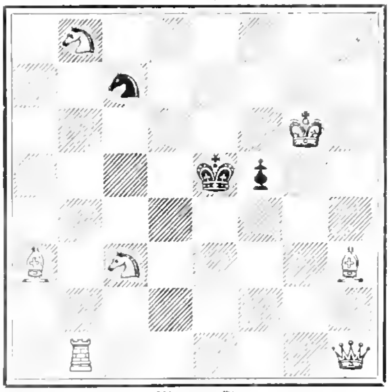
WHITE (8).

White mates in two moves.

No. 2.

By W. Clugston (Belfast).

Black (5).



White (7)

White mates in two moves.

CHESS INTELLIGENCE.

The Inter-University Chess Match resulted in a not unexpected win for Cambridge by five games to 2. The teams being as under:—

Oxford.		Cambridge.	
1. F. Soddy (Merton) ...	0	C. Tattersall (Trinity) ...	1
2. A. George (New College)	0	H. G. Softlaw (Trinity Hall)	1
3. G. Ellis (Lincoln) ...	0	C. Wiles (St. John's) ...	1
4. H. Wilton (Magdalen) ...	1	E. Coleman (Trinity) ...	0
5. F. Babcock (Wadham)	1	W. Burnell (Caius)	0
6. H. Arthur (New College)	0	J. Wright (Trinity)	1
7. G. Waterfield (Christ Ch.)	0	W. Ostle (Jesus)	1
	2		5

The Anglo-American Cable Match took place on March 23rd and 24th, and resulted, as last year, in a victory for the American team by 6 games to 4. Should they succeed in winning again next year, they will retain possession of the Newnes Trophy. Appended is the score, and a brief description of the games.

America.		Great Britain	
1. H. N. Pillsbury	½	J. H. Blackburne ...	½
2. J. W. Showalter ...	½	F. J. Lee ...	½
3. J. H. Barry	1	H. E. Atkins	0
4. A. B. Hodges ...	1	G. E. H. Bellingham ...	0
5. E. Hymes	½	D. Y. Mills	½
6. H. Voight ...	1	T. F. Lawrence	0
7. F. J. Marshall ...	0	E. M. Jackson	1
8. S. W. Bampton	0	Herbt. Jacobs ...	1
9. C. J. Newman ...	½	W. Ward	½
10. E. Delmar ...	1	H. W. Trenchard ...	0
Total	6	Total	4

Board No. 1.—Mr. Blackburne defended with an original variation of Philidor's defence, which cost him a clear Pawn very early in the game. After the exchange of Queens he manœuvred his minor pieces with such skill that a win appeared at one time within the bounds of possibility. Mr. Pillsbury, however, succeeded in escaping with the loss of a Pawn, and equality finally resulted.

Board No 2.—Mr. Lee played the Stonewall attack, and having compromised his game on the King's side, was compelled to Castle on the other wing, where he was subjected to a violent attack. He defended himself skilfully, and judiciously submitted to the loss of the exchange in return for two Pawns, remaining finally with none the worst of the ending.

Board No. 3.—Mr. Atkins played an old-fashioned Sicilian defence, and obtained an early attack on the King's side. In endeavouring to make too much of it he exposed his King to the assault of Queen and Queen's Bishop, Mr. Barry soon forcing the position by the entry of a Rook at Q6.

Board No 4.—Mr. Bellingham obtained considerably the best position in a Queen's Gambit, declined and was tempted to indulge in a promising Pawn sacrifice. Mr. Hodges, however, defended very patiently, and finally won another Pawn and the game.

Board No. 5.—Mr. Mills, defending with the Sicilian, soon became subjected to a violent attack, which he nevertheless managed to survive. Though two Pawns to the bad, he contrived to remain with Bishops of opposite colours, and so drew without difficulty.

Board No. 6.—Mr. Lawrence obtained a good game against his opponent, Sicilian defence, but, after losing a Pawn owing to a mistake, his game broke up with great rapidity.

Board No. 7.—Mr. Jackson, defending the Lopez with Kt to B3 and B to K2, obtained a slight advantage in the end-game. The positions, however, were practically even when Mr. Marshall exceeded his time-limit and so lost the game.

Board No. 8.—Mr. Jacobs won a Pawn very early from his opponent, who declined the King's Gambit, and afterwards made a very weak defence, allowing the English player to wind up with a pretty sacrificial combination.

Board No. 9.—Mr. Ward declined the Queen's Gambit in the normal manner. Pieces were rapidly exchanged, and the defending player was left with a weak Pawn at K5. As, however, White could not attack it without exposing his King, a draw was speedily agreed on.

Board No. 10.—Mr. Trenchard played the Stonewall opening, and, after the Queen's side was blocked, became subject to a King's side attack. He lost the exchange, but owing to the peculiar situation of Mr. Delmar's Pawn it was some time before he found an opportunity of finally breaking through.

Mr. Burn succeeded in winning three consecutive games in his match with Mr. Bellingham, and so retrieving his lost reputation, the match being left drawn with the score standing at 4½ all.

Mr. T. F. Lawrence has won the championship of the City of London Club for the fourth time. His score was 14½ out of a possible 17. Mr. W. Ward was a very good second, only half a point behind; Mr. E. O. Jones being third with 11½. Mr. Lawrence has been singularly unfortunate in the cable matches, having lost his game on all three occasions on which he has played.

KNOWLEDGE
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CONTRASTS IN BAVARIA.

By Grenville A. J. Cole, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

Certain cities, such as Munich and Nuremberg, certain highland resorts in the south, commonly associated in the tourist mind with Tyrol—these are all that the name Bavaria conveys to us in ordinary conversation. Lovers of the arts may add Bayreuth, far away in the north, planted against the granite knot of the Fichtelgebirge; while travellers to Vienna may remember something of the Danube plain, and of the banks of willows between Regensburg and Vilshofen. Bavaria, however, with its plateaux and its devious by-ways, offers a variety of geological features, and is rich in scenic contrasts.

The country, on the other hand, has its drawbacks, which mainly arise from the stolid nature of a prolific and inebriate peasantry; but greater life and lightness are introduced into the community in proportion as one nears the Austrian border. Doubtless the chief charm of the country lies in the quaintness of its towns; but the sites of these, and much of their character, depend upon their geological surroundings.

The great feature of northern Bavaria is the series of plateaux which rise from the left bank of the Danube above Kelheim, and which stretch, under the names of the Rauhe Alb and the Swabian Jura, south-west through Württemberg to the Rhine. After a step down to the north-west, a still broader plateau-country spreads away northward to the Main. As in our own chalk districts, the gentle dip of the strata is accountable for the prevalence of one type of country over so broad an area. The upland of the Swabian and Franconian Jura is formed of Jurassic strata, which run north-east from Stuttgart to near Nuremberg, and then swing round to the north: Nuremberg itself, and many other busy towns, stand on the next plateau, that of the Keuper, which rises with the gently inclined beds to some 1,500 feet above the sea. Viewed broadly, then, we encounter here two systems of strata, the more northern dipping under that which lies to the south and east. The Keuper, with its other Triassic associates, does not reappear until we find its marine representatives upturned and contorted on the flanks of the Alpine chain. The Jurassic beds similarly vanish, as they dip down towards the Danube, to come up again in the Alpine foothills; and the wide basin formed on their backs is filled by Cainozoic deposits, many of them marine, and mostly of Miocene age. Into this lowland, the growing Alps sent down their detritus, and the Miocene beds have been covered in turn by vast glacial and alluvial accumulations.

The northern plateaux form a somewhat irregular watershed. The rivers rise mostly on the surface of the Keuper, in which they have cut deep grooves; but it is difficult to judge, when we cross any one of them, to which system of drainage it belongs. The Kocher, for example, draws much of its water from the higher step, the Jurassic plateau, but escapes down the escarpment and runs across the Keuper to the Neckar, and thence into the Rhine. The Wornitz, a little further east, rises on the Keuper plateau, cuts south across the Jurassic beds, and joins the Danube at Donauwörth. The Altmühl, its next neighbour on the east, takes a similarly determined course; but the Rednitz, starting in the same direction, swings entirely round below Ansbach, runs due north, and joins the Main at Bamberg. All this points to the lack of conspicuous guiding lines in this region of almost horizontal plateaux.

Though we travel here all day at a height of some 1200 feet above the sea, there is little to suggest the elevation. As we rise from the valley of the Neckar, we wind this way and that, for purely agricultural convenience, across a country of great unfenced fields; here and there a scarp, the next step on the plateau, stands more seriously against us, with some fortress-town, like Waldenburg, planted on its level crest. The purple crocus flourishes in the meadows, a reminder of the Alps in this expanse; only at length, the growth of the blue distance, the slow fall of the land on either hand, shows that we have reached the watershed, and stand on the Hohenlohe Plain. The true highland landscapes are here in reality below us; the rivers have force enough to cut ravines, though the atmospheric weathering merely flakes away the level strata, and forms no salient feature on the highland. This is, in consequence, a country of surprises, like the cañon-region of Arizona. Suddenly we may find ourselves dropped into one of the unseen valleys; the road hurries down into a new and unsuspected world; forests climb the steep slopes round us, and bare rock juts out, in mountainous style, among the trees. The villages lose all their leisurely, unhampered, agricultural air, and become cramped in along the watercourses. Here again, if we have left regretfully the Black Forest or the Vosges, we hear with pleasure the rush of streamlets, and the disciplined thunder of the mills. The incident comes as a revelation, only too soon to be taken from us. We may well rub our eyes, when we have toiled up some winding ascent again, far above the timber houses and the red-tiled spires, and emerge upon the vast uniform plateau, across which the approaching night has thrown a veil of purple-grey and brown. Here the air is full of the scent of hay, blowing from the meadows, and making sweet the gathering dusk. The lights shine from scattered farms, each one a beacon in this featureless expanse; you can almost picture the Little People rising from the soft warm earth, whispering to one another, and wondering at a world of stars. One glowing band, raised slightly towards the sky, marks out some clustered city, still seven or eight miles away.

It is thus, perhaps, that we enter Rothenburg, the type of an old Bavarian town. The double gate, the central watch-tower, the narrow street of half-timber houses, take us back to the days of the Thirty Years' War, when the Swedes, like a north wind, swept the plateaux, and passed into the great plain of the Danube. The town stands on the edge of the Tauber valley, and looks across it to the farms and fields. The bridge leading from the west side lies far below, and is easily commanded from the wall; but on all the other sides the position lies open to attack. The structure of the great part of Bavaria has led to the formation of walled towns at every market-centre. In many cases, these are merely clusters of houses, intimately connected with the farmlands that lie beyond their gates. However, in a population brought together for mutual protection, division of labour soon arises, and the lower floors of many houses become turned into the shops of specialists. Other ground-floors to this day, even in Rothenburg, are used as stabling for the cattle; and at morning the cows are driven out through big barn doors from beneath the houses of the burghers, and are brought in again at evening within the protection of the walls. The whole history of this open country is typified in the story of its towns. The collective voice of what was once a settlement of agriculturists became in due course represented in the Rathhaus, where civic custom soon held sway; the craftsman, at first a necessary adjunct, became the critical purchaser and controller of the products of the farms; the great-grandsons of the men who dug the moat and built the ramparts learnt to carve the most exquisite panels on their house-fronts, and turned their proud and self-centred city into a sort of Gothic Florence. From the farrier and the maker of rude weapons sprang the men whose art in metal-work was destined for the table of an Emperor. Yet still, at every turn, the inflocking peasantry, the slow ox-wagons, the shop-windows full of scythes or apple-baskets, proclaim the absolute dependence of the city on the open plateau round it.

The smaller towns throughout Bavaria, which are often mere walled villages, are built upon so uniform a plan as to suggest a common ancestry. The high wall forms a rectangle, with a gateway in the centre of each of the shorter sides. Above these gates rise square towers, capped by conical red roofs. The houses are built with their backs close along the wall, so that the single street is in reality the market-square. The high road runs straight from gate to gate, but expands on either side into a great area, paved with rough stone setts.

The children play here after school-hours; the older women look for their husbands from the doorways as evening settles down; and then, seven or eight together, the men come through the mediæval gates, with scythes over their shoulders, or urging on the tired oxen. Surely this is the stereotype of the ancient laager of the plains, the old square formed by the wagons drawn up at each nightfall of the march; and within it the women and children are gathered, and the cattle are sheltered, and the next day's work is planned.

The old-world forest still covers a large part of the plateaux, and forms a welcome shelter from the cloudless midland sky. Ponds also abound upon the Keuper clays, and provide the peasantry with fish. A man will thus go outside the town-gate on your arrival, catch a weighty perch, and serve it forthwith for the mid-day dinner.

After a few days among the dusty grooves that are regarded as roadways in the forests, it is pleasant to drop down by one of the small streams to the Danube. The contrast provided by the valley-scenery is in itself refreshing. Green hill-sides set with white castles or monasteries; towns holding the passage, built across the roadway, and girt about with towers; a population no longer scattered, but gathered thickly along the one line of communication—all this makes one forget the monotonous upper plateau. At last we reach the foot of the Jurassic slope, and see the green Danube winding in its own alluvium.

Nothing could differ more in character than the two roads from Nuremberg to Kelheim, down the slope of the same geological formation. They divide at Neumarkt, and the one takes to the valley of the Sulza, joining the finer Altmühl river at Beilngries. Such towns as Berching, and other scenes unknown to Bædeker, conspire to give this route an air of high romance. The other road runs across the plateau, bare and uniform, until it drops into the ravine in which even the Danube runs at Kelheim.

South of the Danube, there is little material for gorge-cutting. The one exception is the fine cañon of the Inn upon the eastern frontier, between the water-gate of Scharding and the river-mouth at Passau; but here the rapid stream has cut down into the gneiss of the Bavarian Forest range, to join the Danube, which has become similarly entangled. The gneiss, which belongs structurally to the plateau of Bohemia, forms the north-east border of Bavaria, and was once submerged beneath the Cretaceous sea. Now, by the general Cainozoic uplift, it has become bared again, and forms a steep mountain range, on which the fir-woods gather.

As already hinted, the basin between the ancient gneiss and the Franconian Jura on the one hand, and the Alpine foothills on the other, has served as a gathering ground for all manner of detritus. Marine and lacustrine deposits were at one time common on it;* but these older Cainozoic beds were formed before the Alps began to rise, and when the basin was wider and more open. They became folded into the Alpine foothills on the south, and were soon covered in the lowlands by the alluvium of the Alpine streams. In the great

* C. W. Gumbel, "Geognostische Beschreibung des bayerischen Alpengebirges" (1861), pp. 756 and 770.

days of denudation, when the Alps were at their height, enormous quantities of pebbles were brought down; one fan of *débris* spread across another; the frequent flooding threw several rivers into one; and the whole lowland became invaded by a vast detrital cone. On the slope of this inland delta, the rivers still run down in force; but they are now carving out shallow valleys in their old accumulations, and are exposing the Miocene beds below. Floods, such as those of 1899, tend, however, to restore matters, and the whole country between the Danube and the Alps is in a state of flux, and gives us an amazing picture of the decay of continental barriers.† The growth of the delta has forced the Danube up against the hard rocks to the north, and is probably responsible for the ravine of Kelheim in the Jurassic limestone, as well as for that in the gneiss from Vilshofen to Passau. Regensburg lies at the most northerly extension of the cone, 140 kilometres from the source of its material in the Alps.

The great southern tributaries of the Danube run north-easterly, eroding, as M. Reclus‡ points out, their right or eastern banks; this is attributed to the earth's rotation, which affects these moving bodies of water equally with the winds. The result has been a steady shortening of their tributaries on the east, and a steady elongation of those entering from the west. It is, however, noteworthy that the north-easterly trend does not set in until the coarse deposits near the Alpine chain have been left behind;§ the resisting character of these relics of glacial times has probably allowed the general northward slope, modified by any local irregularities, to play the most important part in directing the courses of the streams.

The glacial beds in Upper Bavaria often consist of tough conglomerates, which at one time choked the valleys, just as they did in the gorges of the Alps above Trieste. The rivers, attacking these beds with youthful vigour, before their entry on the plains, have cleared out their courses again through them, showing fine sections on the vertical walls of the ravines. The frontier-road from Neu-Otting to Salzburg runs on a plateau of these deposits, and the River Salzach for the most part is seen far below in its ravine. At Burghausen, which is set low down to guard a bridge, the castle is built on the face of the cliff itself, and the single street is narrowed almost to a foot-path, with one line of houses between it and the swift green water. A period of excavation has evidently again set in, as is the case in so many of the choked valleys in our own islands. The rivers in old days must have been more rapid, flowing from yet higher hills; but the very intensity of denudation along the crests supplied them with too much material. Nowadays, the clearer, if slower, water is removing the obstruction and is gradually restoring the topography of the mountain-slopes, much as they were at the close of Pliocene times.

As is the case in so many areas of deposition, a sinking of the floor of Bavaria can be proved to have taken place between the northern plateaux and the Alps. The edge of the Bavarian forest, where the contrast of the alluvium and the crystalline rock is so conspicuous, is, according to Prof. Suess, a line of differential movement. The Bohemian highland, with its forest-rim, thus owes some of its eminence to the sinking of adjacent land

† Compare "The Heart of a Continent," Knowledge, Vol. XX (1897), p. 284.

‡ "Géographie Universelle," tome III.

§ *See* Lepsius's "Geol. Karte des Deutschen Reichs," sect. 27.

It is thus that great receptive basins continue to be available for the successive accumulations that come down; at the same time, the highlands that supply the pebbles, the sands, or the clays, escape being entirely banked up and covered over by the products of their own destruction. Gumbel|| believed that the finer material covering the glacial beds in southern Bavaria was deposited in a lake, formed as the Alps themselves sank, and thereby altered the curvature of their northern slopes. Prof. Heim has urged the same subsidence of the central chain to account for the sinuous lakes, which are clearly flooded valleys, on either side of the Alps in Switzerland. From this point of view, the curious lakes, the Chiem See and others, with their low and often boggy shores, now found in the southern plain, are relics of a vast sheet of water which spread down to Munich in recent geological times.

The Alps form a natural boundary to Bavaria on the south; but the watershed, along which the metamorphic rocks crop out, falls within Austrian territory. Consequently, as Reclus has remarked, Bavaria does not possess the sources of any of her larger rivers. The Isar, for example, rises on the back of the wonderful rock-wall above Innsbruck; but a good part of its course through the forests of the highland is none the less effected in Bavarian territory. The Inn, however, has performed all the grand part of its journey, in a valley almost unsurpassed in Europe, before it emerges on Bavaria, where it only adds in flood-time to the wreck and desolation of the plain. It recovers, as we have seen, some trace of its former grandeur when it encounters the northern crystalline rocks near Passau.

Such of the Alpine foothills as fall within Bavaria repeat the features of the Bavarian Forest, though with more variety of scarp and slope, owing to their being formed of stratified materials. Fir-woods clothe them for the most part, and it is strange to pass from these gloomy uplands to the vast fan-taluses known as the Bavarian plain. It is thus in the extreme south, or again in the north-east, on the bold descent to the Danube from the forests of Bohemia, that we may best realise the charm of Bavaria as a land of fascinating contrasts.

MODERN PISCICULTURE.

BEING A DESCRIPTION OF THE SOLWAY FISHERY.

By T. A. Gerald Strickland.

The interesting and most useful pursuit of artificial propagation of fish is no *fin-de-siècle* discovery. The Chinese have practised it from time immemorial down to the present day. A quite modern traveller, C. F. Gordon Cumming, says:—"I inspected some artificial fish-tanks, the lowest of which is periodically drained by means of an endless chain of buckets worked by a treadmill."* The Romans also went in rather extensively for fish ponds, and spent large amounts on them, indeed the ponds of Lucullus are said to have cost a sum of about £30,000 in our money. The Roman system was very simple compared with modern fish culture, for "it appears to have consisted rather in conveying the spawn of fish from the spawning bed to an exhausted lake, and thus replenishing the waters, than actually ejecting the ova and impregnating them with milt by an artificial process."† In the middle

|| *Op. cit.*, pp. 852 and 872.

* "Wanderings in China" by C. F. Gordon Cumming.

† Dr. E. Percival Wright in "Animal Life."

ages the monks kept ponds of carp in preparation for their fast days, and Jacobi, who wrote an elaborate treatise on the subject, brought the art down to our own time.

When in Scotland last autumn I had the opportunity of examining at leisure a large modern fish farm, the Solway Fishery, and it is this that I am about to describe.

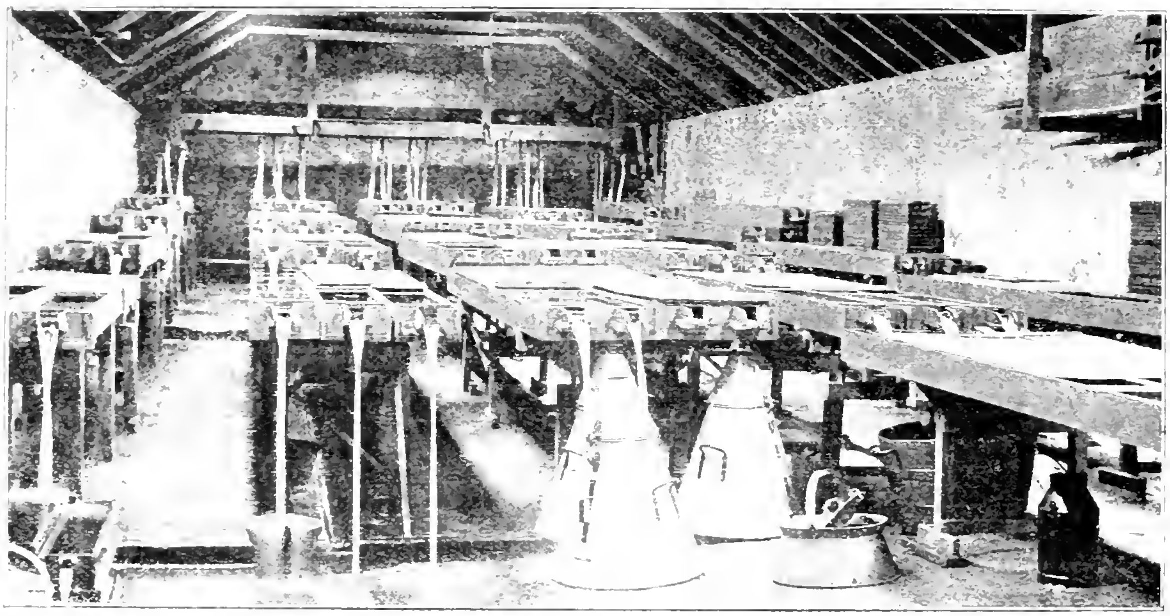
Most of the quotations appearing in this article, the sources of which are not stated, are from "An Angler's Paradise," by Mr. J. J. Armistead, who, some nineteen years ago, started the fish farm on its present site.

The fishery, which is situated in a beautiful valley, surrounded by heather-clad hills and grouse moors, is sheltered from gales by extensive fir woods, and, what is naturally of the greatest importance in an undertaking of this sort, is copiously and unfailingly watered by the Pow and Tannox burns. The source of the latter arises on the mountain Criffel, which stands like a grim sentinel in the background. The grounds of the fish farm, which comprise many acres, are divided into various sized ponds, connected by "raceways" through which water is always flowing.

Each pond is inhabited by fish either of different species or of varying ages. For instance, one pond has 800 specially selected British two-year old trout, another from 2,000 to 3,000 large Rainbow (Salmo irideus) and American trout (S. fontinalis), and others are the homes of innumerable fry, two-year old salmon (S. salar), dace, bream, roach, perch and other fish. One stagnant pond is inhabited by carp, and there is also a pond of stickleback in which the greater duckweed flourishes. There is never any scarcity of water as, besides the two streams already mentioned, there are splendid springs; but the water from these is unsuitable for fish until its character is entirely altered by flowing through raceways which are inhabited by various aquatic plants and mollusks.

The fry ponds are about 60 feet long by 4 feet broad, and those that contain the adult fish are about the same length but from 9 to 10 feet broad. The newer ponds, now in course of construction, are lined with concrete, and so are easier to keep clean. At the end of each pond is a perforated zinc plate that allows the water to flow through but keeps the fish prisoners. This has to be scrubbed every evening to keep clean and free from weeds, as, the water supply being natural, in the event of a heavy storm, there would be a rush of water which, if the outlets were insufficient, would flood the ponds mixing all species and sizes of stock together! This, as may be imagined, would be fatal for more reasons than one, for Shakespear was quite correct in stating that "fishes live in the sea—as men do a-land; the great ones eat up the little ones."‡

Yes, all fish of the same size and age have to be kept in separate ponds, as trout are great cannibals; yearlings eating fry, three year olds devouring yearlings, and so on. The stock fish, when allowed to spawn naturally, have been seen eating their own ova! When the fry have become yearlings "it is found necessary to take them out of the pond and sort them. If this be not done the larger fish will eat many of the smaller ones, and at the end of two or three years their sizes would be altogether disproportioned, some weighing two or three ounces, others as many pounds. I have known cases of trout (Salmo fario and S. levenensis) reaching the weight of four pounds in two years, whereas it usually takes three years for a trout to reach a pound."§



Hatchery at the Solway Fishery. (*Photo by* W. Anderson.)

The process of modern fish culture is briefly as follows:—Trout and salmon are the only fish, as a rule, artificially spawned and hatched, the so-called coarse fish being allowed to make their own family arrangements in the ponds. For instance, perch spawn naturally on weeds.

Salmon are generally disposed of in the "eyed ova" stage, as, being anadromous, they will not come to perfection if kept entirely in fresh water. According to

‡ Pericles, II., 1.

§ "Atmospheric and other Influences on the Migration of Fishes." by J. J. Armistead.

Isaak Walton, "The Salmon (Salmo salar) is the king of freshwater fish, and he has, like some persons of honour and riches, which have both their Summer and Winter residences, the fresh rivers for Summer and salt water for Winter to spend his life in."

We must conclude then that it is a case of "uneasy lies the head that wears a crown," because a more modern authority (Frank Buckland) remarked in a lecture, "perhaps the most unfortunate thing in the world is the salmon. Everybody and everything, from the otter to the fisherman, persecutes him." Again, "the trout then comes to eat the eggs, next a whole swarm of flies and insects; then the water-ouzel, who goes to eat the flies, is shot by ourselves under the idea that the bird is after the eggs, and not after the flies; the result is that not one egg out of ten thousand ever becomes food for man."[‖] So, though fish culturists cannot keep the salmon till they arrive at maturity, artificial spawning and hatching obviates these initial evils, and, so to say, gives the young salmon a fair start in life.

The spawning season of trout is from October to January inclusive, and they begin to spawn when about three years old. The stock fish are examined from time to time by an expert, who can tell at a glance if they are ripe for spawning. An expert can also distinguish the males from the females easily, as a rule, which would not be a simple matter for an ordinary observer to determine.

When the fish are ready to spawn they are netted from the stock ponds, and the finest selected are removed to the spawning shed in large two-handled tubs. The female fish are placed in a large trough with divisions, and the males in a large tub. Two or three females are removed from one of the divisions of the trough in a landing net, which is then held over a carefully dried basin and the ova gently squeezed (stripped) from the fish into the receptacle. The fish are then returned to the trough but are placed in an empty division. When the basin is considered to contain enough ova, a male is netted from the tub, held over the basin, and his milt squeezed on to the ova.

The spawn and milt are then gently stirred together, when they adhere for a short time and then again become separate. When this occurs the ova are well washed and placed on "grilles." These grilles are shallow trays with wooden sides and glass bottoms made of glass rods placed side by side, which keep the eggs from washing away, but allow the water to flow over and through. Each grille, which holds from 3,000 to 4,000 eggs, is then removed to the hatchery. The hatchery is one of the most interesting buildings on the farm, and the photograph conveys a good idea of its internal appearance when in full work. The water is laid on through underground pipes so that the supply shall never freeze in transit, and the hatchery itself is heated with hot-water pipes, as before this was done, the supply of water on arrival sometimes froze and consequently might have ceased flowing through the hatchery boxes had not an attendant remained present all night in order to prevent such a contingency. The hatchery boxes containing the grilles must have a constant stream of water running through them. These boxes are provided with removable covers, as the process of hatching has to take place in the dark. When the alevins appear a part of the cover is removed so that the fish can be in light or dark surroundings as they prefer. Spawn takes about three months to hatch according to temperature.

The ova are forwarded to all parts of the world when they are "eyed," which occurs from 50 to 60 days after spawning. The packing of the ova is a very important matter and the eggs are never touched by hand. Wooden trays are constructed with bottoms of well-seasoned perforated zinc. On the zinc is laid a sheet of felted moss (a suitable moss is cultivated for the purpose), and over that a piece of fine net is placed, then a layer of eggs, then more fabric, more felt, fabric, eggs, and so on. Each tray holds three layers of eggs, and eight trays are placed in an inner case which is packed round with sawdust. For sea voyages of long duration an extra tray with perforated bottom is filled with ice and put on top of the inner case; this lowers the temperature sufficiently to retard completion of hatching till arrival at the destination. Sometimes, for very long journeys, the eggs are packed simply between moss felt without intervening fabric.

Rivers and lakes in Australia, the Cape, New Zealand, Canada, etc., have been stocked with fish from this farm, and have done well, so evidently the eggs travel satisfactorily in this way. Only spawn is sent abroad, but fish, from the fry stage to adult, are sent all over Great Britain and Ireland for stocking rivers and lakes. The fry are retained in the hatching boxes for six weeks after emerging, and they require no food for the first month, as they have an umbilical sac, on the contents of which they live till their mouths are in a sufficiently developed state to take external sustenance; for the alevins on first leaving the egg, though more finished in appearance than the wormlike offspring of the kangaroo, are by no means the "speckled beauties" they become eventually. After six weeks or so the fry are removed to small fry or nursery ponds. The adult fish are fed twice a day and the fry four times; their food consists of horseflesh, beef, etc., which is passed through mincing machines. The best food of all is said to be shrimps, but these, though the company keeps a private trawler for the purpose, are not always procurable; other foods are also largely used, and one of them is maggots. There is a large maggot "factory," where all meaty scraps, offal and dead vermin are collected and quickly turn into an appetizing (?) nutritive food. The meat is suspended on an iron grating, and the grubs, as they appear, fall through into a tray and are swept up, meal fed, scalded and divided among the ponds. Tadpoles are also used in immense quantities, and frog spawn is procured literally by the ton every season to breed from. Crustaceans, mollusks, insects, etc., are also of great benefit, but these I will return to later. The food of the adult fish is thrown on the surface of the ponds. It is a curious sight to see the fish fed; one moment, you look on an unruffled sheet of water reflecting the trees and clouds as a mirror; the next, an attendant having thrown a handful of mince in, the pond suddenly becomes a rough sea, and some of the inmates leap right out of the water in the exuberance of their spirits, their sleek, spotted sides glistening in the sun. The fry are too small to swallow the ordinary minced meat, so they are fed in a different manner. An instrument called a feeder is used. It is a box about 9 inches square and 4 inches deep, made with wooden sides, a perforated zinc bottom, and a long handle. A little food is put in this box, which is then half immersed in the water of the fry pond and moved from side to side. The smaller particles of food gravitate through

[‖] "Life of Frank Buckland," by G. C. Bompas.

the perforated bottom, and the thousands of fry which can be seen feeding form a pretty sight. The large pieces left in the feeder are given to the adults.

The fish are sent all over the country in specially designed cans, externally not unlike milk cans. In the packing room the fish are placed temporarily in tanks, sorted as to size and age, and then put into the travelling cans which are three parts filled with water. The cans have false tops, which form receptacles for ice. The jolting of the train or vehicle keeps the water splashing against the perforated bottom of the false lid filled with ice, which effectually cools and oxygenates it. The fish are not fed for some time before starting on a journey, so as to prevent them fouling the water, and they evidently do not mind shaking, as "in some cases fish have been carried miles over rough and trackless mountains in carriers specially made, which are fitted with wooden handles, by means of which two men can carry each over the roughest ground, hauling them up the face of the steep rocks and floating them across streams. Where mountain ponies can be used we can send carriers that can be slung pannier fashion across their backs."*

Large fish on arriving at their destination are dipped in salt water before turning out into their new abode. This immersion in salt water seems to be the great cure for the dreaded fungus (Saprolegnia ferax) and the various parasites fish are so subject to. The yearling stage seems to be the most satisfactory for stocking waters, though fry have turned out extremely well, too, and, of course, are very much cheaper.

I must not bring this article to a close without mentioning the ponds of various beautiful aquatic plants. Some plants and fish seem to have formed a kind of mutual benefit society, the former "consuming carbon and returning oxygen," and the latter "consuming oxygen and returning carbon." Of course certain species of plants are more beneficial than others; for instance, some, besides producing oxygen, form perfect strongholds, or colonies of the much-to-be desired members of the crustacea and mollusca that suit, and indeed are so necessary to, the fish.

Interesting experiments in acclimatization are carried out on aquatic plants from all parts of the world; Japan and India supplying their quota. Besides those plants that are grown from a strictly utilitarian point of view are others that, if not of much use as food producers, are at all events harmless to fish and cultivated for their magnificent foliage and beautiful flowers.

* The Company's Catalogue.

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor Alfred C. Haddon, M.A., SC.D., F.R.S.

III.—THE PASTORAL SOCIETIES.

In my last article I dealt with the Kalkas, as illustrating a simple and homogeneous human society. I now propose to take a general survey of three main types of the pastoral mode of existence. In doing so I follow in the steps of M. E. Demolins ("La Science Sociale," XV., p. 173, etc.). The selected types are the following:—

1. The type of the Steppes.
2. The type of the Tundras.
3. The type of the Deserts.

These three groups agree in the intense development of the family community, and the absence of higher social organisations, but they differ in the organisation and extent of the community of the family.

In the Steppes the family community attains its highest degree of purity and intensity. We have already seen how the steppes produce abundant grass on which large flocks can be supported, and how the family communities find in the pastoral life sufficiently complete resources. They are not obliged to have recourse to accessory industries, being so self-contained the communitary influences of the pastoral art are scarcely influenced from the outside. Nowhere do communities attain a higher degree of independence, nowhere is paternal authority so powerful or uncontested. The father is in very deed magistrate, priest, and king.

In the Tundras a marked weakening of the family community is observable. Here grass is scarce and of poor quality, and its place in the far north is taken by the lichen known as "reindeer moss." The herders of reindeer in this inhospitable circumpolar region, the Lapps of Norway, the Samoyads of Siberia, and the Eskimo of North America are well known, and of these the Samoyad is the least changed. Life cannot be maintained, as further south, by the pastoral art alone, and so recourse must be had to fishing and hunting. The reindeer are well broken in and trained, and have reached a high excellence as draught beasts. The sledge, too, is perfectly adapted to the physical difficulties presented by the tundra. The reindeer is a veritable "staff of life"; its skin makes the tent, and constitutes the chief material for clothing. Its body is the main food for the Samoyad, and its hide and sinews are made into harness, cordage, and thread. It is the only animal which is fitted to draw burdens across the tundra, a quaking bog in summer, a howling frozen plain in winter. In the latter season the Samoyad hunts, attacks and snares the white bear, brown bear, sable, fox, lynx and other fur-bearing animals; in summer he catches enormous numbers of birds, geese, swans, duck, etc. Parties of Samoyads bring furs to the markets across the tundra, before the melting of the snow makes it impossible for him to take heavy loads across the tundra; those who remain behind complete the season's harvest; these are rejoined by the trading parties before the rivers burst free from ice, and the whole country becomes an impassable swamp. But the two occupations of fishing and hunting, which require agility and strength, tend to augment the importance of the young to the decrease of the influence of the old, that is to say, of the natural chiefs of the community.

In the tropical deserts of North Africa and Western Asia the pastoral art is insufficient to support the population. The insufficiency in this case is due to extreme heat and drought, which only admit of sparse and poor grass. Hence the camel is the dominant animal in that zone where this social type is most characteristic.

It is necessary to have recourse to supplementary resources. These resources are indicated by each particular locality; but the main features are similar, since these deserts lie between the tropics with their rich productions, and the southern temperate region, with a population enriched by cultivation. The pastor of the desert will go to one or other confine to procure the necessary supplement to his means of subsistence, which he exchanges for various fabrics for which his flock furnishes the raw material, and which are manufactured by his family. This mode of life was early developed into an organised system of trade, thus the patriarch of the desert naturally becomes the leader of a caravan, and acts as a middleman between the civilizations of the Mediterranean and the savage tribes of Central Africa on the one hand, and the civilizations of the Orient on the other.

This simple difference in the conditions of life imposes a grave transformation on the family community. Each year very long journeys have to be made from the interior of the desert to its borders in order to exchange merchandise. Other communities, also on the march, are met with, and dispute pasturages and wells, as these are few in number and limited in extent. The merchandise must always be protected, hence the trading parties must be as numerous as possible, and have experienced chiefs—the most experienced possible, it is a matter of life and death.

This necessity constrains the development of the family community. When a community is too numerous in the prairies a portion separates under a new patriarch, usually one of the brothers of the old one. Here a community is never too large. They do not separate into family groups, but remain together and become a *tribe*.

The tribe contains several hundreds, sometimes several thousands of persons. In order that such multitudes may exist on so poor a soil they are divided into small groups or "douars," which are like the companies of a regiment. But all these groups, who follow one another on the march, form only a single community under the direction of one chief, and are always ready to rally at the first signal and at the least danger.

In this way the family community has extended to the proportions of the tribe. It is the first complication; but it induces another which is yet more characteristic.

This grouping permits, even necessitates, the elevation of certain specialists in the midst of the group, thus appear the special ministers of religion such as the well-known marabout arab. The marabout is at the same time a specialist in intellectual culture, and to him is given the teaching of the children. Thus two functions are withdrawn from the father, those of religion and teaching, it is a first and grave diminution of the patriarchal attributes.

But this is not all: the direction of affairs is also taken away from the heads of the families; they are constrained on the one hand by the council of the tribe which is composed of the most notable patriarchs, and on the other by the chief of the tribe. It is necessary for the chief to be armed with great authority, for he must defend and protect not only the public interests but also those of private life; he not only organises attack and defence, but he also regulates the watering and commonage of the flocks, and indicates the pasturage: he is thus the patron of labour.

The attributes of the patriarch are very sensibly diminished, nevertheless the type still belongs to the societies of the simple communitary formation of the family, for the tribe is only an enlarged patriarchal family.

These three types differ in their aptitude for dispersal, and in the influence they have exerted on neighbouring peoples. The pastors of the steppes are apt to swarm, but are not qualified to organise invasion or to remain masters of the conquered country. The pastors of the tundras are not liable to expand, also there is no question of their organising invasions or of conquering other peoples. The pastors of the deserts are notoriously apt to spread, to organise invasion and to remain masters of the conquered countries.

The aptitude of the *Pastors of the Prairies* to spread is naturally explained: they are nomads and consequently accustomed to shift their quarters; in order to invade they have only to march in a straight line towards a definite point instead of wandering here and there on the steppes: they have scarcely to change their ordinary life. Further they possess the horse, which is an incomparable means for transport. The problem of the commissariat, so important and difficult in a military expedition, is spontaneously solved, their food—*i.e.*, their flocks—marches with them.

So far good, but here commences the difficulty, the population of this type are not good at organization. These societies are formed of absolutely independent families. No superior organization exists above the simple patriarchal family. At certain times a number of people from different families may associate in a more general group, as, for example, to go on a pilgrimage to some distant lamasery, but these caravans are purely accidental and the power of the chiefs of the caravan ceases as soon as the caravan reaches its goal.

In these societies of small autonomous groups, without constituted government, and subject to a centrifugal force, all collective action is very difficult. To produce it, to blaze out into an invasion, it needs a rare combination of favourable circumstances, which renders one man prominent, some chief of a caravan, for example, able and celebrated, fit to lead these masses which are without cohesion.

It is precisely because this combination of circumstances is so exceptional that these populations overflow their natural boundaries only at very rare intervals. But then the invasion is the more formidable, and such are the innumerable throngs who precipitate themselves in the wake of an Attila, of a Jenghiz-Khan, of a Tamerlane.

These very names suggest the idea of unorganised multitudes, rushing like a torrent, but not advancing like an army. The original inaptitude of the type for any large grouping, for any complicated organisation, and for surpassing the narrow limits of the patriarchal community, is manifestly brought to light.

For a very good reason these invaders are precluded from organising and administrating the conquered peoples; how could they bring to them the social elements, the organization of public life which they themselves lack? Thus is explained the state of anarchy and the rapid disappearance of the empires of Attila, of Jenghiz-Khan, and of Tamerlane; they traversed history like a flash of lightning which rends a cloud and immediately disappears into obscurity.

The Pastors of the Tundras are still less favoured. They have not even the first requisite for invasion, the means of transport. They only possess the reindeer, the dog, the sledge, and skates. With these it is impossible to go beyond the limits of the Boreal region. It is a serious difficulty to enter into a campaign. In these icy regions it is absolutely impossible to agglomerate a large number of men and animals on account of the scarcity of pasturage, and large areas are necessary for even a small herd of reindeer.

Never has history recorded, nor will it ever record, a single invasion by Eskimo or Lapps.

With the Pastors of the Deserts we meet with a type, the most capable not only to swarm but to organise invasion, and to remain master of the conquered country.

As means of transport they have the camel and the Arab horse. The nomad life renders these people even more facile for movement than the pastors of the steppes, as the poverty of the pasturages necessitates the frequent shifting of their abode. No nomad surpasses the Arab in celerity of movement.

Thanks to the habitual life of the caravan, for the tribe is only a permanent caravan, this type possesses the complete framework of an army. It is an army always on the march, always in exercise, always ready to shift the camp, with a council of chiefs and a commander-in-chief. And the army is as well prepared for attack as for defence, for life in the deserts is a continual struggle against inimical tribes. When a favourable occasion offers to expansion the tribe affords an effective organization, ready at a moment's notice, with a proved chief, who knows his men, and is known by them.

This type is also very superior to that of the steppes from the point of view of administrating the conquered country.

No one can ignore that the empire of the Arabs has played a very different part in history from that of Attila and Tamerlane. There has been an Arab civilisation and it was brilliant; the justice and the administration of the Caliphs are celebrated, and justly so. They knew how to rule not only the Orient but Spain, they knew how to develop not only culture but the arts, letters, and the sciences. For there was an Arab art and science. No one has ever heard of an art or science of the Tatars or of the Mongols.

The aptitude for government is equally the result of the permanent organisation into tribes. As tribes, these societies possess the machinery for government under those conditions which assure permanence and solidity. In this, the Arab society approaches the complicated societies of the west. The tribe is a natural and permanent grouping which does not tend to dissolve after victory. The necessity to annually sell the products of fabrication puts the Arabs also into relation with town life.

There are certain characteristics that are common to the peoples under review. There is:—

(1) Community in occupation. The nomad pastoral art requires a numerous staff (*a*) to herd and make use of the flocks that are necessarily spread over considerable areas; (*b*) to defend themselves and their flocks, for they can have no other security in these solitudes; (*c*) to counteract the tedium of isolation, and to meet the adventures of a wandering life; (*d*) to provide for the numerous articles of domestic use, for most usually each group has to be completely self-sufficing owing to the distance it is from all the resources of commerce.

(2) Community in property. Grass grows without the labour of man hence there is no work expended, which of itself tends to create a proprietary right. The soil is unappropriated by individuals or even by family groups for the nomad population. Extensive commonage is more useful than the exclusive possession of a restricted definite area.

(3) Community in the family. Since a pastoral life demands a numerous staff, the various households derived from a common ancestor tend to remain together under the rule of the community, instead of separating to establish themselves independently. The girls naturally separate, but only to enter into another community, into that of their husbands. Such is the type of the patriarchal family which groups a large number of households around each chief or patriarch.

What characterises this group of societies is not only the intense development of the community, but also *the absence of all higher social organisations.*

These societies are entirely limited to the community of the family, it is precisely this which gives to all this group of societies its great character of simplicity. None of the complications which result from the higher organisations of social life, or of public life, can be produced here, since these organisations do not exist. Or, at least, they only exist latent, so to speak, in the state; they are not separated from the family, they are blended with it.

It is in fact, the chief of the community who fulfils, according to circumstances, the diverse functions, which elsewhere are specialised, of patron, teacher, religious instructor, policeman, magistrate, sovereign. These functions appear here as the attributes and extension of the paternal authority.

In a word, each community is in itself a little, complete, autonomous state; it is a social microcosm.

Two principal effects are produced by the communitary organisation:—

1. *Aversion to Hard Work.*—It is evident that people who live under the *régime* of the community, who draw upon the common estate, not in proportion to their labour, but in proportion to their needs, are naturally inclined to work as little as possible; each has a tendency to rely on the labour of others much more than upon his own, and as a consequence is tempted to make the least effort.

The indolence, passiveness, fatalism, which characterise the pastoral peoples, or those derived from pastors, appear to owe their origin to the communitary organisation.

2. *The Minimising of Individual Initiative.*—Men who are born, who live, and who die in a community; who during their whole life have no need to take a personal decision, nor to incur any responsibility; who in everything have to submit to the authority of the chief of the community; who cannot do anything without the sanction of this community; men, in a word, who are perpetually considered as minors, can have no initiative. How can they have even the conception of it? One sees here the cause which has so profoundly developed the principle of authority in the East, and which has made the patriarchal power the highest expression of this authority.

The absence of hard work and of initiative is very slightly inconvenient in pastoral societies, where the problem of life is greatly simplified.

Man is not naturally inclined to work: the grass, which is the principal resource of the herders, requires no labour, it renews itself each year. The soil upon which he pastures his flocks cannot be lost to him, for it belongs to everyone. Each enjoys it in perpetuity, despite his improvidence and comparative laziness. This happy proprietor has no dread of mortgage, of usury, nor of dispossession.

Mankind is by Nature little inclined to initiative. The pastoral art is, by its nature, immobile; it is not susceptible of improvements, the pastor has only to do tranquilly what has been done since time immemorial by his predecessors; he may act by routine at his ease, without compromising his interests.

THE ROYAL ACADEMY EXHIBITION.

THE labour bestowed by the Royal Academy of Arts in selecting works for its annual exhibition is enormous, while the efforts made to deal justly and generously with the multitude of artists and others who send in works for acceptance, are such as can only be bestowed by a highly trained and a high-minded body of men.

Works in sculpture, oil and water colour, black and white, and architectural designs, pour into the cellars of Burlington House during the three days granted to would-be exhibitors until they total some 14,000. The names and addresses of the authors of each work have to be recorded, and the thousands of pictures, or framed works, have to be sorted and arranged, more or less according to size, in order that they may be viewed.

When the viewing day comes, a council of ten Members of the Academy sit and see the whole of these works. It is obvious that men of the highest standard in their art, trained in eye and mind, are able to reckon up the relative merits of very many of the works brought before them in a moment. A Council of Examiners conducting a *viva voce* examination on some hundreds of students, seeking to pass in French, would dispose in an instant of such as could not speak three words of that language. Thus fall some thousands of works, which their authors and friends esteemed highly, no doubt on the principle "Where ignorance is bliss 'tis folly to be wise." Tolerable works receive more attention, but the greater number of these follow the multitude downstairs into the cellars. Anything that the eagle-eyed Council regard as good work is set aside as doubtful (that is, accepted to be hung if space permits), and these works are so numerous that it is utterly impossible for anything like the whole of them to obtain a place upon the walls. A very small quantity of exceptionally good works—seldom more than eighty—are "accepted" to be "placed" in excellent positions.

The labour of viewing some 14,000 works is enormous. A procession of bearers carry the pictures in a stream before the Council, the names of the various artists not being mentioned. Sometimes the stream rolls on, dull and heavy, at other times it sparkles with "good things." Woe to the mediocre work that finds itself amongst the pearls; had it appeared in the midst of the dull and heavy it might have had a chance, but in all things comparisons, if odious, tell. A very small part of a second can be given to the larger number of the works, as here described.

A vast number of the works have now to return to the cellars. As the works leave the large gallery, where the Council sit, they are classified at once by a staff of commissioners stationed in the various galleries, and are thus alphabetically registered. Some thousands of cards are issued to the authors of these works, the educational effect of which should be to make each recipient "A sadder but a wiser man."

The first part of the Council's labour is now over, and so great is the strain of the concentrated attention given to the work, that most of its members are exhausted. This portion takes from seven to eight days.

Then there comes a selection of the selected works—a second viewing. The "doubtfuls" are far too numerous for the space yielded by the walls of the Academy, and hence this fresh sifting.

The duty of the Hanging Committee, consisting of five Members, now begins.

The Academicians, whose works have been passed in outside the turmoil of the 14,000, have first to be considered. This year the Academicians are particularly strong, and their works are, as a whole, such as have not been seen for many years. Each Academician is entitled to have four only of his pictures upon "the line," a graceful act to the outside artists, who otherwise would hardly ever obtain this desired position. Places of honour are apportioned to the finest works of Members, and after that, places of honour and position are given to the "accepted" works, and the best of the doubtfuls.

The mass that is left is picked over for the remaining space. The sizes of pictures tell for or against their being hung, as also does the subject, and the colour of the work. Let anyone sit down in a room of the Exhibition and observe how well balanced in size, subject, and colour, most of the walls are, and consider the labour of the Hanging Committee.

No Member of the Council (with the exception of the President and Keeper) is allowed in the Galleries until the hanging is complete. Then the other half of the Council, together with the President and Keeper, go through the rooms. They pass the work of the Hanging Committee, should it be approved, but it very often happens that what is considered an injustice in the hanging of a picture is at this final viewing altered by the Council.

But the labour is not yet over. First and foremost, the endeavour of the Hanging Committee has been to give as good a show as is possible; still errors may have crept in. Has any "accepted" picture, with its red star, been overlooked? Has an old exhibitor who once earned fame for himself been lost sight of? If such is the case, the Committee orders such works to be hung, and down must come other works to make room. No alteration can take place after this.

Everything that can be done to act justly and generously has been done, but there are hundreds of "doubtfuls" for which no place can be found, and some, no doubt, are better than works that are hung. Perhaps these did not fit, perhaps they were overlooked. Also, as it is impossible to satisfy everyone whose work finds a place in the Exhibition, there must always be a considerable amount of annoyance caused to exhibitors whose work is poorly located.

The Royal Academy of Arts holds itself highly. On the Press day none of its Members appear. The critics are left severely alone to say their worst or best. The critic who finds fault is less likely to be laughed at for his ignorance than he who falls into the error of lauding an inferior piece of work.

ARTIFICIAL "RESEAU PHOTOSPHERIQUE."

By the Rev. Arthur East.

Every student of solar physics is acquainted with Sir W. Huggins' drawing of solar granules which is given in all the text books. Since that drawing was made, some thirty years ago, we have had the magnificent photographs of Mons. Janssen taken at Meudon, showing with marvellous detail the granulation of the solar surface, and exhibiting somewhat the same rectilinear arrangement of certain portions of the photosphere, which Mons. Janssen has named the "reseau photospherique." So far no explanation has been given for the disposition shown in Sir W. Huggins' drawing, so that failing a better the following is offered, derived chiefly from a study of artificial granules—that we have here a beautiful demonstration of the exchange we know must always be going on, by means of vertical currents between the upper and lower levels of the photosphere. Masses of the heated lowest strata must of necessity rise, become relatively cool, travel hither and thither over the upper surface, so far as other heated masses also striving equally to extend themselves will allow, and sink again to make room for others, and rise again

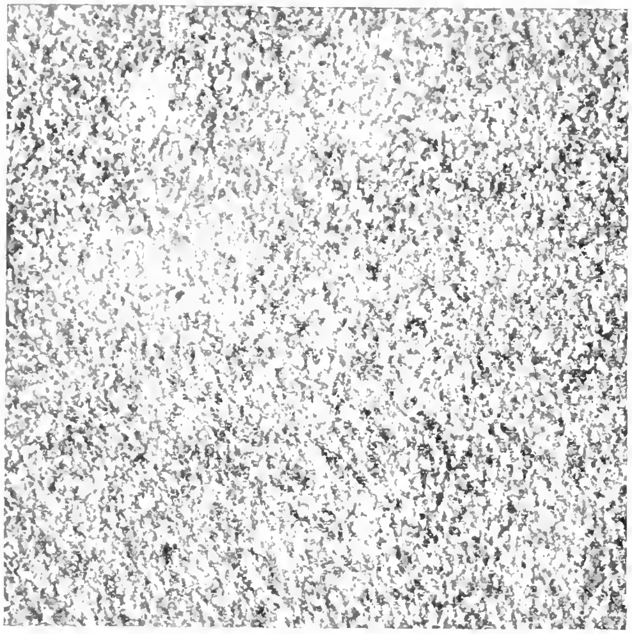


Fig. 1.—Photograph of the Sun's Surface, showing granule pattern.

in an endless series. And to these larger masses applies no doubt M. Janssen's remark as to, what he names, the "éléments granulaires."

"On sent que la sphère a été la forme première des éléments, ces éléments sont constitués par une matière très mobile qui cède avec facilité aux actions extérieures."

That is to say, the rising masses of heated photospheric material are normally spherical, and the rectilinear arrangement forming the "reseau" is the result of the mutual pressure of the masses.

An attempt has been made to reproduce these reticulations by the artificial method previously given in Knowledge, and some examples are presented in the accompanying illustrations, together with two reproductions of the Meudon photographs. The method consists in floating granules of the curd of milk in a saturated solution of salt and water, and putting the pan containing the solution on a hot plate; almost immediately spherical or at least round-headed masses of the granules begin to rise, and when these masses meet they mutually compress one another, the lines of impact being mostly straight: thus we get a very regular "reseau," with this remarkable piece of information that the lines of separation between the areas are formed exclusively by descending granules, the middle of the reticulations being the area of ascending granules. Let me quote again M. Janssen's description of his "reseau."

"Un examen attentif des photographies montre que la surface de la photosphère n'a pas une constitution uniforme dans toutes ses parties, mais qu'elle se divise en une série de figures plus ou moins distantes les unes des autres, et présentant une constitution particulière.

"Ces figures ont des contours plus ou moins arondis, souvent rectilignes, et rappelant le plus ordinairement des polygones."

These polygons are a very distinct feature in the artificially produced "reseau photospherique."

There is one point absolutely essential to the success of making the granules play in this manner—they must be able to move freely in the fluid, any tendency to become flocculent, or to sink to the bottom in a mass, instantly stops this pattern forming; in this case spots may be formed in the compacted granule masses, as explained in a previous article (Knowledge, December, 1897), but no granule patterns will play on the surface.

Now, if these artificial granules truly represent the behaviour of the solar granules, it is evident that the conditions on the sun when spots are formed are exactly the opposite of those when reticulations are fashioned, the former depending on the compactness, and the latter on the diffusiveness of the photospheric materials.

Consequently, it became important to ascertain at what period of sun-spot activity Sir W. Huggins' drawing was made. Sir William very kindly informs me that "the drawing was made on April 26, 1866, one year before the minimum, the previous minimum of 1856 having been a remarkable one. The diagram does not represent the actual appearance of any one area of the sun's surface, but some of the more characteristic of the modes of grouping of the bright granules."

It seems to be always taken for granted that maximum "sun-spottedness" and maximum solar activity are the same thing—in fact, convertible terms. I venture to submit that it may be nothing of the kind, but the exact opposite may be nearer the truth: when the solar energy is at its maximum the photosphere may be so torn and churned and dispersed that it has not compactness enough left for spots to be able to form, and if

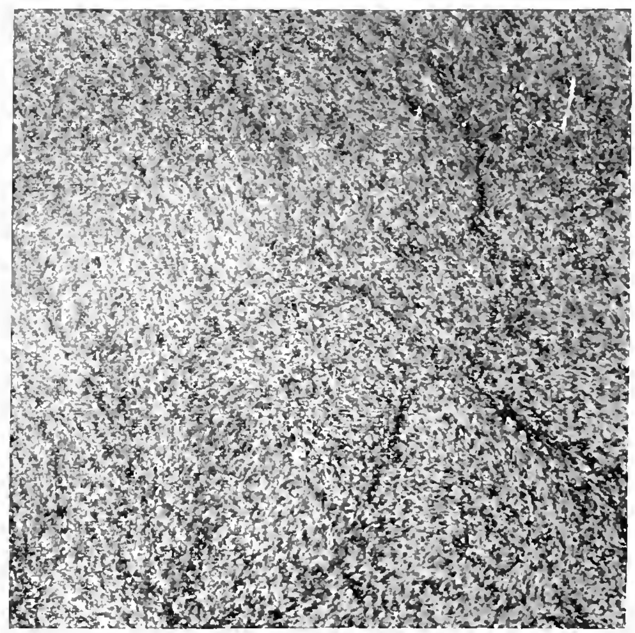


Fig. 2.—Artificial Solar granule pattern.

some few form they are small and soon obliterated. M. Janssen observes:—

"J'ai pu constater, par nos series photospherique que quand le soleil est a l'epoque d'un minimum, les taches ont une surprenante tendance à se dissoudre. L'annee 1876 en presente plusieurs examples remarkables."

I would suggest that spots are a sign of reviving solar fury, which does not reach its maximum until it has rent the sun's outer garment into shreds and tatters and the sun-spot minimum has arrived.

It may be objected that even at a period of sun-spot maximum the total area occupied by spots is very small

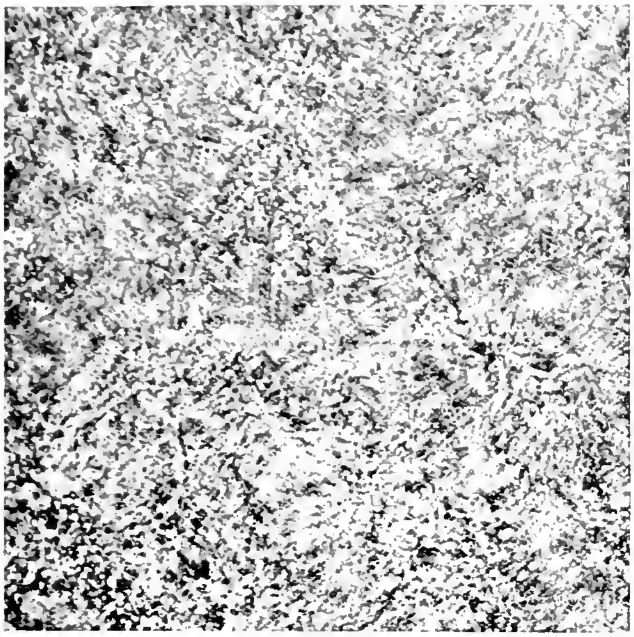


Fig. 3.—Photograph of the Sun's Surface, showing granule pattern.

relatively to the solar surface, and that we should see more signs of this enormous disturbance of the photosphere if it really existed; but if reference is made to Professor Hale's spectro-heliographs given in KNOWLEDGE for August, 1898, it will be seen at once that the solar surface is vastly more disturbed than the spots shown telescopically give any indication of, and, indeed, that the telescopic appearance of the sun is exceedingly misleading. As was to be expected, sun-spots are after all only symptoms of the state of the photosphere, which may or may not be in a spot-forming state, a fact which, owing to the extreme interest attaching to the spots themselves, one is perhaps often inclined to forget.

Again, there is the obvious reply that the magnetic curve so closely follows the sun-spot curve that we are obliged to allow that when the magnetic curve indicates a maximum of magnetic disturbance the sun-spot maximum curve must also indicate a maximum of solar disturbance; but the conclusion is not necessarily true, and I would urge that the electricity generated by a rush of escaping steam, say, from a volcano, or from a boiler, depends not on the volume of steam, nor on the fierceness of the fire below, but on the friction of the steam against the sides of the orifice, and that the same volume of steam, if it were free to escape where it would, might generate no electricity at all. The two cases may not be parallel; magnetic storms may not be caused by the in-rush or out-rush of vapours in a great sun-spot; but until we know what the cause is it would not be at all safe to infer a maximum outbreak of solar energy because we find a maximum magnetic disturbance.

Or, again, it may be said that the prominences by their number and height must clearly indicate, coming as they do so markedly in direct proportion to the sun-spot maximum, that solar activity, the sun-spot maximum, and the prominence maximum are synchronous.

It is agreed that the prominence maximum synchronises with the spot maximum. I claim it as a strong proof of the theory now advanced; if a common gas jet is partly obstructed the flame will shoot out a surprising distance, and the smaller the orifice the longer the jet; so when the photosphere is diffuse as it is, ex hypothesi, at minimum the solar flames have but little altitude, when compact all the force is concentrated at the openings of the spots and vast jets of flame are expelled.

There are some important consequences which will follow if the foregoing explanation of the cause of granule patterns be admitted as a true one; the explanation, namely, that the absence or presence of spots depends on the free floating of the solar granules in the vapours out of which they are formed; or, on the contrary, on their subsiding into strata much denser and nearer to the solar surface. The Poles will never exhibit spots, for there the photospheric matter will always be too closely packed, owing to slowness of rotation, for the surface to be broken through; as the churning of the photosphere, produced by a maximum, subsides the granules will gradually sink down again first towards the Poles where rotation is least; when the new spot cycle will again begin, and continuously sink towards the Equator, whither the spots will follow.

The question of the irregularity of the eleven-year cycle will then be a question as to how quickly or how slowly the granules composing the photosphere are allowed to sink down after a maximum outburst of solar energy, and each sun-spot period will depend in some degree on the state in which the photosphere was left by the preceding one.

The cause of the eleven-year cycle itself remains, of

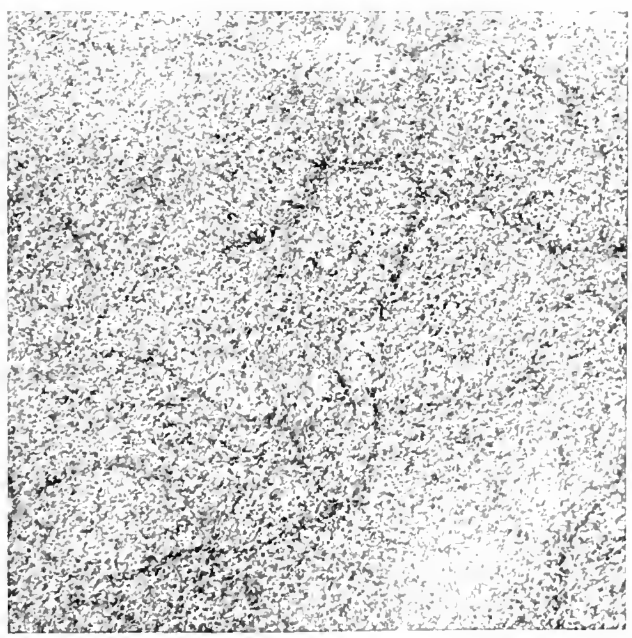


Fig. 4.—Artificial Solar granule pattern.

course, still untouched, but possibly if the cause of the irregularities were known we might get some hint as to the direction in which to look for a solution of the main problem.

PHOTOGRAPHS OF THE NEBULÆ M. 8 SAGITTARII AND OF H VI. CETI.

By Isaac Roberts, D.Sc., F.R.S.

NEBULA M. 8 SAGITTARII.

R.A. 17h. 57m. 33s. Decl. 24° 23′·0 South.

The photograph was taken with the 20-inch reflector on the 11th July, 1899, between, sidereal time, 18h. 2m. and 19h. 32m., with an exposure of the plate during ninety minutes.

Scale—one millimètre to twenty-four seconds of arc.

The nebula is referred to in the N.G.C. No 6523, G.C. 4361, *h* 3722.

The photograph shows it to be a cloud of nebulous matter extending in *north following* to *south preceding* direction forty-eight minutes of arc, and about the same extent in *south following* to *north preceding*. Near the *preceding* end the nebulosity is dense, with a bright star apparently touching the margin, and giving it, on the negative, the appearance of an eye on one side of which is a prominent space free from nebulosity; there are also extensive spaces in some parts of the nebula which are almost free, and some quite free, from nebulosity; these give it a structural appearance.

There are many stars of between 8th and 17th magnitude either involved or seen in projection upon the nebula, and on the following side they resemble a cluster of bright stars, but I do not think they are physically connected with it; they are probably between the earth and the nebula.

The place we should, with our present knowledge, assign to this nebula in the order of stellar evolution, would be an early state prior to a spiral formation.

But we must have patience as well as moderation in our speculations, for millions of years will probably elapse before it is completely developed into a cluster of stars.

NEBULA H VI. CETI.

R.A. 0h. 42m. 36s. Decl. 25° 50′·6 South.

The photograph was taken with the 20-inch reflector on the 25th December, 1899, with an exposure of the plate during ninety minutes.

Scale—one millimètre to twenty-four seconds of arc.

The nebula is referred to in the N.G.C. No. 252, G.C. 138, *h* 61=2354, and is figured by Herschel in the *Phil. Trans.*, 1833, Pl. 14, Fig. 52, p. 495. Also by Lassell in the *Mem. R.A.S.*, Vol. XXXVI., Pl. 1, Fig. 1, p. 40.

The photograph shows the nebula to be a spiral viewed at an acute angle. It measures twenty-four minutes of arc in diameter, which is in the direction *north preceding* to *south following*, and is studded with numerous condensations of a stellar character; there are also six stars, of the normal type, which are probably seen in projection upon it. These, together with the stellar condensations, will afford reliable fiducial points for the measurement from other stars around the nebula with the object of detecting any movements either of rotation or of translation that may in future take place in it.

Both these nebulæ are between twenty-four and twenty-six degrees of south declination; they can therefore be photographed under much more favourable conditions in observatories near, or to the south of the equator, and there can be no doubt that Dr. Gill at the Cape, or Prof. Pickering, will give a good account of them.

If we consider the nebula H VI. Ceti with reference to the evolution of stellar systems its place would be far in advance of M. 8 Sagittarii. In this the convolutions are not only formed but the development of the stars in them has also reached an advanced state; some of them appear like small well-formed nebulous stars; and the nebula in time—who can imagine how long—will appear as a star-cluster, and resemble those which have already been photographed and described in the volumes of "Photographs of Stars, Star-Clusters, and Nebulæ."

ASTRONOMY WITHOUT A TELESCOPE.

By E. Walter Maunder, F.R.A.S.

V.—OBSERVATIONS OF THE SUN.

It may seem at first sight a useless and idle suggestion that beginners in Astronomy should set themselves to the redetermination, on the roughest scale and with the simplest of instruments, of astronomical constants which were first determined more than five millenia ago, and which are now ascertained in our modern observatories to an almost inconceivable degree of exactness. Yet if we think for a moment we shall see that this is but the method which experience has taught us is the most effective in learning the other physical sciences. We know perfectly well we can never make a chemist of a boy by giving him a course of chemical text-books. We set him to repeat for himself experiments which were first made in the very infancy of the science. We make him determine again the combining weights of different elements, though these are known far more exactly than he can possibly work them out; and in so doing, he not only acquires skill as a worker, but the subjects of his study become real to him; he learns to know them in a sense which no amount of reading about them could ever supply.

It has been the drawback of Astronomy that this course has so seldom been adopted, and the inevitable result has been seen in that no science whatsoever has produced so large a proportion of paradoxers and cranks. There is no science, the chief facts of which are so widely disseminated; there is none of which those facts are so little known by practical personal observation.

Much of this unfortunate state of things is due simply to the modern tendency to live in towns. Here the smoky atmosphere dulls the shining of the heavenly bodies; the crowded buildings hide the horizon and curtail the view of the sky, and at night the artificial lights in streets and houses completely drown the feebler glitter of the stars and draw off attention from them. We do not need moon and stars as our ancestors did, and therefore we do not notice them. We do not need to observe the sun to give us the time of the year; our almanacs tell us that. Therefore, except in observatories, the sun's place in the heavens remains unnoted.

But in early times this observation was of the very first importance. The constellations as we have seen, were mapped out some 5000 years ago. (Knowledge, February, 1900, p. 37.) Before that was done—how long before we cannot tell—the length of the year had been determined and the apparent path of the sun amongst the stars had been laid down. The exact methods and instruments those early astronomers employed are not recorded, nor, if they were, would there be any reason for slavishly copying them in repeating the work to-day. But in all probability the first astronomical instrument was one of Nature's own providing, the natural horizon. And wherever a fairly good one is available, the beginner in astronomy is strongly recommended to make use of it.

If this were so then no doubt those primeval observers

Knowledge

NEBULA H VI CETI

NEBULA M. 8 SAGITTARII

had their attention drawn to the fact that as seen from some given station the sun rose and set behind different portions of the horizon at different times of the year. In an open country free from mists and ground fogs, this observation would be one of greater delicacy than might be expected—a delicacy the greater according to the distance of the horizon and to the number and distinctness of the objects which could be recognised upon it. They would serve the purpose—so to speak—of the divisions of a gigantic azimuth circle, and a few years' careful and sedulous record of the exact position of the sun at rising and setting would give an exceedingly close determination of the true length of the tropical year.

They would do more than this. They would give the means of determining the south point of the horizon—in other words of the meridian line. A line drawn at right angles to the line joining the point of rising and setting, would be *roughly* but not precisely the meridian line. But the mean of all the points this indicated as due south would, unless the horizon were much more obstructed on one side than the other, approximate very closely indeed to the true south point.

The conditions for different observers will vary so widely that it would be useless to give detailed directions as to making this observation, and it would be useless for another reason. It is most important that those who take up the pursuit of naked eye Astronomy should make their observations independently, and too detailed instruction beforehand would defeat the very object for which those observations were made.

It would soon be felt that the natural horizon was a rough and inconvenient instrument to work with. The objects ranged along it which serve as division marks are apt to be irregular, the horizon itself to deviate very considerably from an ideal plane. So perhaps the next step in the observation of the sun would be the erection of some means of observing the shadow it casts—in other words a simple sun-dial.

It is probable that the earliest sun-dial was simply the spear of some nomad chief, stuck upright in the ground before his tent. Amongst those desert wanderers, keen to observe their surroundings, it would not be a difficult thing to notice that the shadow shortened as the sun rose higher in the sky, and that the shortest shadow always pointed in the same direction—north. The recognition would have followed very soon that this noonday shadow changed in its length from day to day. A six-foot spear would give a shadow at noonday in latitude 40° of 12 feet at one time of the year, of less than 2 feet at another. This instrument, so simple, so easily carried, so easily set up, may well have begun the scientific study of Astronomy, for it lent itself to measurement, and science is measurement; and probably we see it expressed in permanent form in the obelisks of Egyptian solar temples, though these no doubt were retained merely as solar emblems ages after their use as actual instruments of observation had ceased. An upright stick, carefully plumbed, standing on some level surface, may therefore well make the first advance upon the natural horizon. A knob at the top of the stick will be found to render the shadow more easily observed.

The careful study of this instrument will enable the meridian line to be marked with some considerable exactness. This should be done by taking an observation at some time in the morning, a good while before noon, drawing a circle with the base of the stick as centre, and the length of the shadow as radius, and then in the afternoon watching till the tip of the shadow again lengthens itself to exactly reach the circle. We shall find the north point lie midway between the two positions of the shadow. Here again we must trust not one observation but many, and the mean will give us a very close approximation to the true meridian.

The date of the summer or of the winter solstice would not be very readily ascertained from such an instrument—the very word solstice intimating that the change in the sun's position at that season is scarcely perceptible. But the time of the equinoxes can be fixed with sufficient exactness, since the length of the noonday shadow of a six foot rod will vary in our latitude more than an inch a day at that time of the year.

A far exacter instrument for the observation of the sun can be made with the very slightest trouble; a light tube, 5 feet 4 inches long, made either of tin or of pasteboard, and covered at one end with a cardboard disc, with a pinhole one-sixteenth of an inch in diameter, carefully perforated in its centre, and at the other with a cap of oiled paper, will enable the sun to be observed with great ease. If this tube is directed to the sun an image of the sun will be formed by the pinhole on the oiled paper some six-tenths of an inch in diameter, and if a cardboard disc some ten or twelve inches in diameter is fixed to the tube—the tube passing through the centre of it—so as to screen the observer from the rays of the sun, he will find the sun's image on the oiled paper quite bright enough to observe, and much better defined than the shadow given him by the rod.

The next step would be to fit the tube with a graduated circle. The material of which the circle should be made and the manner in which it should be graduated may be left to the ingenuity of the student. Protractors of horn, metal, glass, or card can be very easily purchased and may well serve the purpose. The reading of the circle may be accomplished in one or two ways; the circle may be fixed firmly to the telescope so as to turn with it, and the altitude of the tube may then be read by a plumb-line dropped from the centre of the circle across its circumference; or the circle may itself be fixed in one position with respect to the vertical, and the tube may be turned round upon the same centre as that of the circle. In this case the tube should be supplied with pointers to read on the circle.

The tube being provided by a vertical circle and constructed so as to turn in a vertical plane, should also have its stand so arranged that it may turn in a horizontal plane also, and it should be fitted with a second circle, the centre of which is the pivot on which it turns. This circle must be fixed in the horizontal plane, and our instrument will then be a rough model of an altazimuth.

Its first use will be to determine the meridian—by taking an observation in the morning reading both circles—then in the afternoon, waiting until the sun had descended to the same altitude a second time, and then reading the azimuth circle again. To set the telescope to the azimuth midway between these two azimuths would be to set it roughly in the meridian. Here again the observations should be repeated many times, and the mean should be taken as the true south point.

The south point once found, the observation of the varying altitude of the sun at noon from day to day throughout the year would be a simple and easy matter. At midsummer and midwinter the meridian altitude of the sun will not vary perceptibly for a fortnight or more, so that we shall obtain a number of observations for the greatest and least height of the sun Half the difference between these two must plainly be the obliquity of the ecliptic; and the altitude which is the mean of these two extreme altitudes must be the altitude of the equator, that is to say of the sun when it is at the equinox. The date of the equinox will be determined to the nearest day without any difficulty, for if we set our tube in the meridian, and pointing to the equator—in other words at an altitude equal to the co-latitude of our station—a single day's variation in the height of the sun at the time of the equinox will make a change in the position of the sun in the field of our pinhole tube of about four-tenths of an inch—an amount which the very roughest of observers could not overlook.

Such an instrument, simple as it is, would therefore enable the observer to determine the date of the equinox to the nearest day, and consequently the length of the tropical year, and also the obliquity of the ecliptic and the co-latitude of the place of observation. The exactness with which these could be determined would depend upon the skill and patience of the observer, who could, ere long, if he were sufficiently exact, begin to detect causes of irregularity in his results, some due to defects in his instrument, and some due to causes apart from that apparent motion of the sun which it was his first object to determine. These we must leave for the present, though their detection and the discovery of their cause would give a keen delight to anyone with a true observer's spirit, especially when he found that a proper allowance for them brought his observations into ever closer and closer accord.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

SEARCH FOR AN INTRA-MERCURIAL PLANET.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—With reference to Prof. E. C. Pickering's proposal to search for an intra-mercurial planet during the total phase of the solar eclipse of May 28, I should like to remark that if such a planet exists it is probably *exceedingly small.* In fact it must be too small to be distinguished when in transit over the sun, or it would certainly have been discovered long ago unless indeed its orbit is much inclined, and it is enabled to pass N. or S. of the sun at its conjunctions, which is highly improbable. The instances of rapidly moving dark spots quoted by Webb may be dismissed as too doubtful to throw any definite light on the subject. The observations are too imperfect to afford data for the satisfactory computation of the orbit, though Lescarbault's reported discovery of 1859, March 26, enabled M. Le Verrier to derive approximate elements. But Lescarbault's description is probably the most untrustworthy of all, for the same observer announced to the Academy of Sciences on 1891, January 11th, that he had discovered a bright body in Leo, which he could not identify, and had therefore concluded it to be a new star. This "new star" proved to be the planet Saturn: Lescarbault, so easily deluded in this case, was no doubt similarly mistaken in 1859, when a normal sun-spot must have encouraged visions of a mobile planetary body. In this connection it may be added that M Emmanuel Liais, whose decease has recently been announced, was watching the sun in Brazil at the very hour when Lescarbault thought he had detected "Vulcan," and positively averred that no object of the kind was visible.

At various times I have obtained some thousands of solar observations with different instruments, but chiefly with refractors of $4\frac{1}{4}$in. and 3in., and a reflector of 4in. aperture with a view to the detection of an intra-mercurial planet. The months of observation were usually March—April, and September—October. On some days the sun was examined at short intervals during the whole time that he remained above the horizon, but I never met with any object representing an intra-mercurial planet. Occasionally a suspicious looking spot—pretty round, small, and without penumbra—was noticed, but upon being closely watched it always proved a veritable sun-spot. I believe that spots with certain planetary aspects appear more often than is generally supposed, and perhaps it is no wonder that their character has been sometimes mistaken by persons who have formed hurried conclusions without applying proper tests. W. F. Denning.

Bishopston, Bristol,
May 5th, 1900.

S. U. CYGNI.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—As but little so far as I know has been published of the movements of Miller & Kempf's Variable, designated by them as S. T. Cygni, and by a late writer in the *Astronomical Journal* as S. U. Cygni, the following observations though lengthy may be worthy of a portion of your valuable space.

Date.		Magnitude observed.	Maximum due. G.M.T.	D.	H.	M.
Augt.	24	6·51	Augt.	23	17	39
,,	27	6·51	,,	27	13	55
,,	28	7·07				
,,	29	7·22				
,,	30	7·22				
,,	31	6·71	,,	31	10	10
Sept.	1	6·71				
,,	23	6·91				
,,	4	6·63	Sept.	1	6	25
,,	5	7·12				
,,	7	7·17	,,	8	2	41
,,	9	7·08				
,,	11	7·15	,,	11	22	56
,,	12	6·66				
,,	13	7·13				
,,	14	7·25	,,	15	19	11
,,	21	7·96	,,	19	15	27
,,	22	7·10				
,,	23	7·13	,,	23	11	02
,,	25	7·08				
,,	26	6·98				
,,	27	6·49	,,	27	7	58
,,	29	7·18				
,,	30	7·18				
Oct.	1	7·18	Oct.	1	4	13
,,	2	7·19				
,,	3	7·30				
,,	5	6·79	,,	5	0	29
,,	7	7·27				
,,	8	7·30	,,	8	20	45
,,	9	6·71				
,,	10	7·35				
,,	12	7·38	,,	12	17	00
,,	13	6·89				
,,	14	7·27				
,,	15	7·27				
,,	16	6·58	,,	16	13	15

Date.		Magnitude observed.	Maximum due. G.M.T.	D.	H.	M.
Oct.	15	7·27				
,,	16	6·58	Oct.	16	13	15
,,	18	7·11				
,,	19	7·10				
,,	20	7·08	,,	20	9	30
,,	21	7·08				
,,	22	7·27				
,,	23	7·35				
,,	24	7·08	,,	24	5	45
,,	24	6·08				
,,	25	6·56				
,,	26	7·21				
,,	28	6·97	,,	28	2	00
,,	29	6·93				
,,	30	7·39				
,,	31	7·32	,,	31	22	16
Nov.	3	7·20				
,,	5	6·79	Nov.	4	18	31
,,	15	6·85				
,,	19	7·27	,,	20	3	32
,,	22	7·23	,,	23	23	47
,,	23	6·91				
,,	28	6·95	,,	27	20	02
,,	30	7·13	Dec.	1	16	17
Dec.	2	6·61				
,,	3	7·12				
,,	4	7·19				
,,	5	6·56	,,	5	12	32
,,	11	7·31	,,	9	8	48
,,	12	7·31	,,	13	5	03
,,	15	6·56				
,,	16	7·06	,,	17	1	18
,,	25	6·71	,,	24	17	18
,,	26	6·56	,,	27	14	04
,,	28	6·30				
			,,	30	10	19

These observations were made in the evenings not later than 8 p.m. local time, which is six hours and twelve minutes behind G.M.T.

Following the elements given by the discoverers I have given the dates upon which maxima were due G.M.T. Their period is 3.844 or 20h. 15m. 21.4, while Luzette's (Paris) period is 3.846 or 20h. 18m. 14 2, making quite a difference. To what I have said of this star in March KNOWLEDGE I will add nothing till I see more of it. DAVID FLANERY.

Memphis, Tenn., U.S.A.,
11th April, 1900.

WIRELESS-TELEGRAPH RECEIVER.

Mr. R. Child Bayley, Editor of *Photography*, writes to us:—

"The interesting letter from Mr. Norman Robinson in your May issue and the appeal by Mr. Little, leads me to think that possibly those gentlemen may not be acquainted with the very remarkable paper by Mr. Glew read before the Royal Photographic Society about a year ago. In that communication the author described a method by which it appeared perfectly possible for the Hertzian disturbances to which a flash of lightning gives rise, so to actuate the shutter applied to a camera, that the plate itself should be exposed to record the lightning before the light waves had time to reach the plate."

This paper was published in the *Photographic Journal* of March, 1899.

ORNITHOLOGICAL NOTES. In the absence from England of Mr. Harry F. Witherby, the Ornithological Notes are held over.

Notices of Books.

"Text-book of Palæontology." By K. A. von Zittel. Translated and edited by C. R. Eastman. Vol. I. (Macmillan.) Illustrated. 25s. net. Professor von Zittel's "Handbuch" and the smaller "Grundzuge (Outlines) der Paleontologie" have attained such a world-wide reputation, and contain such a vast amount of matter which can be found nowhere else within the limits of a single work, that it is a matter for congratulation that the latter is at last produced (so far as the Invertebrates are concerned) in English. The English edition has been undertaken by Mr. Eastman, of Harvard College, with the assistance of a brilliant staff of American specialists; and the result seems, as might have been expected, all that can be desired. At the commencement of the undertaking it was intended to give a literal translation of the German original of the "Grundzuge," but as the work progressed it was found, with the lapse of time since the publication of the former, the incorporation of so much new matter was essential in order to bring it up to date that this became a practical impossibility. Accordingly, after the translation of the chapters on Protozoa and Cœlenterata, which stand almost in their original form, it was determined, with the assent of the author, to rewrite and expand the remaining sections so as to bring them thoroughly abreast of the present state of science. It will be found, therefore, that while some of the later chapters, especially the one on the Mollusca, are but little altered from the German text, a large portion of the work although following the general lines of the original, is practically a new production. A praiseworthy feature is the large amount of bibliographical matter added in the form of foot notes, which renders the work more valuable not only to the ordinary student, but likewise to the advanced specialist.

Taken as a whole, the work is written in a much more technical style than the corresponding portion of the "Manual of Palæontology" by Nicholson and Lydekker; and it cannot, therefore, in any sense be regarded as a "readable" volume, in which the mere amateur will find delight for his leisure moments. It is, in fact, a purely scientific manual, written for students and scientific men; and as such may lay claim to the highest praise. To assimilate its contents the reader must, indeed, be well acquainted with the meaning of a large vocabulary of abstruse terms; and almost the only improvement we can suggest would be the addition of a glossary of such terms.

In a brief notice like the present it is impossible to attempt criticism; and we can only state that the definitions are drawn up with a precision and preciseness which are really admirable, while the illustrations (reproduced from the original) are all that can be desired. Especial attention may be directed to the figures of Ammonites, in which the form of the complicated "sutures" is in most cases clearly shown on a small segment of the shell in a manner rendering easy the determination of the generic characters. We hope before long to have the opportunity of according an equal hearty welcome to the Vertebrate section of this most valuable and important work.

"The Boyhood of a Naturalist." By Fred Smith. (Blackie.) 3s. 6d. It is only once in a while that we come across such an optimistic book as the one under notice. All who wish to recall the happy days of boyhood, and to again rehearse the buoyancy of youth—and who does not?—will do well to read this most exhilarating narrative of a naturalist. The author, as a boy, was devoted to natural history, and preferred a country ramble ten times over to a game of cricket. He relates the stratagems by means of which he avoided the national pastime, and the fines he had to pay as the result of following the bent of his mind. Very amusing is the account of a lecture on the snail given by the author as a boy of twelve years of age, and the enthusiastic description of the building of an aquarium will afford delightful reading. We feel sure that the decidedly charming way in which the author has narrated his experiences will commend itself to all young people who are fortunate enough to gain access to the book, the pages of which will indeed appeal to all lovers of nature whether of large or small growth.

"A First Book of Organic Evolution." By D. K. Shute, M.D. (Kegan Paul.) Illustrated. 7s. 6d. net. "There is nothing great in the world but man, nothing great in man but mind, and nothing great in mind but character." Dr. Shute's idea as to the goal of evolution seems to be men with great minds of high character, and he holds that the subject is of such vast importance and commanding interest as to be a necessary ingredient in what is called a liberal education. The truth of the theory of evolution is herein assumed, and the author disposes facts collated by other observers in a way which he regards as most likely to be helpful to the beginner in finding the shortest route through the labyrinthine maze of ways and bye-ways investing the whole fabric. The title is misleading, as no one unacquainted with the elements of general biology can appreciate the theme, and, seeing that the book amounts to no more than an essay, the ground covered is too comprehensive to admit of the amplification necessary for those beginning the subject. A good bibliography is provided, and some excellent coloured plates adorn the text.

"Practical Exercises in Elementary Meteorology." By Robert De Courcy Ward. (Ginn.) The teaching of meteorology in this country, though scanty at present, is probably on the increase, and many who are engaged in it will regard with interest this American book, in which Mr. Ward offers us the fruits of some ten years' experience as "instructor in climatology" at Harvard (U.S.). American ways of dealing with weather, as well as American weather, differ from ours; and if this probably detracts from the usefulness of such a book "on this side," one may see compensating advantage in a widened view; perhaps, also, if we are not too "insular," in the discovery of some things brother Jonathan does better than ourselves. After showing how weather may be studied, so far, without instruments, the author gives a good account, first of "elementary," then of "advanced," instrumental observations (a somewhat rough distinction, of course). With the aid of a sheet of weather data for six days at a number of American stations, the pupil is next shown, in an interesting way, how to draw isotherms, isobars, wind-arrows, etc., and generally prepare a "daily weather map." Further on, he learns to make "composite portraits" (not photographic) of various features of cyclones and anticyclones. Then we have a discussion, in eleven chapters, of the correlation of certain elements of weather, and weather forecasting; next, six chapters on "problems of observational meteorology," followed by 24 pages of tabular matter relating to humidity, dew-point, etc. A frequent practice throughout the book is that of telling the pupil to do this or that, and then putting a number of suggestive questions as to what he finds when he has done it. In the section on instruments the author might have been more explicit as to the best hours for observing temperature, etc. The nephoscope is described, but not the sunshine recorder (which is growing in importance with us). The weather table lacks dates, and is incorrectly referred to in several places as "the table in chapter VIII." (where it is not). This chapter is headed "weather," but the word is, confusingly, sometimes restricted (as here) to the state of the sky, and precipitation, occasionally used in the common wider sense. Mr. Ward, in general, writes clearly and well; though here and there doubtful statements are met with. There is also some useless repetition (compare, e.g., what is said of the sirocco on pp. 103 and 133). Indeed the general plan of the book tends, we are afraid, to repetition. Apropos of this, we note the remark (p.183) that "the correlation exercises will, as a whole, teach few entirely new facts to the brighter scholars who have faithfully completed the preceding work." The aim appears to be to "impress firmly" the lesson "by repeated illustrations." Still, we are inclined to think those later sections might be improved by a little condensation, if not rearrangement. Once more, the subject of thunder-storms and atmospheric electricity is hardly touched upon. Having said this much in criticism, we heartily commend the work as one likely to be of real service to the school teacher and others. The "get-up" of the book is excellent. There is an appendix containing suggestions to the teacher, and another on the equipment of a meteorological laboratory.

"Annual Report of the Board of Regents of the Smithsonian Institution for the year ending June 30th, 1897." Report of the United States National Museum. Part 1. (Washington Government Printing Office.) This report consists of two parts, the first being the report of the acting assistant-secretary of the Smithsonian Institution in charge of the National Museum, the second embracing papers describing and illustrating collections in the museum. The report forms a handsome volume of over a thousand pages, with upwards of five hundred illustrations. It is distributed gratuitously with lavish munificence, as many as ten thousand copies being in this way disposed of. If, in face of facts like these, it is permissible to offer a kindly criticism, we should like to suggest that the world has been reminded by the greatest of ethical authorities that the heathen will not be heard by reason of their much speaking. It is similarly possible to write too voluminously, and there is, we think, a disposition on the part of our American contemporaries to suppose that the importance of a publication is magnified by increasing its length, rather than concentrating its contents. But there can be no question of the value and importance of this latest addition to a wholly valuable series. The descriptive catalogue of recent foraminifera which Dr. Flint has compiled, with the eighty beautiful plates accompanying the monograph, will prove a mine of wealth for students of this interesting branch of the protozoa. The account of the pipes and smoking customs of the American aborigines, based upon the material in the United States National Museum, which Mr. Joseph D. McGuire contributes, runs to nearly three hundred pages, and being provided with well over two hundred pictures, exhausts, we should suppose, nearly everything that can be said on the subject. Mr. Wert Tassin writes in a similarly exhaustive manner on the "Properties and Classification of Minerals." Mr. George H. Cooke deals with "Easter Island," and Dr. Otis Tufton Mason with the man's knife among the North American Indians. The remaining part of the volume is occupied with an account of the arrow points, spear-heads, and knives of prehistoric times, by Dr. Thomas Wilson. A mere statement of the contents of the volume indicates the wide range of subjects comprised, but to impart anything like an adequate conception of the sumptuous character of the feast which is here set before the reader is quite impossible in a short review. We can only hope it will be possible for students to examine the volume itself in one of our national libraries, since it is only in this way that an appreciation of how things are done in America is possible.

"Practical Zoology." An Elementary Course of Practical Zoology. By the late T. J. Parker and W. N. Parker. Macmillan's Manuals for Students. London. 1900. Price 10s. 6d. It is sometimes made a reproach to the zoological workers of the present day that they deal too much with "outside zoology"; but the publication of a volume like the present does much to remove this reproach, at least so far as a selected series of typical animals are concerned. The work before us is indeed essentially of the "section-cutting" type; and puts before the student in a lucid manner the mechanical construction of representatives of the leading groups of animals, together with the functions of the different organs described. The work is to some extent an expansion of the plan followed in the second half of the late Prof. Rolleston's "Forms of Animals," but gives a much greater preponderance to the Vertebrates as compared with the Invertebrates. Since, however, the book is intended for medical students (among others) the large amount of space devoted to the former group is an advantage rather than otherwise; and in any case, as the authors themselves state, a comparative study of the several types of Vertebrates forms as good a training for beginners as can be desired. Whether, however, the title chosen for the work is altogether a happy one, may be an open question. In our own opinion the term "practical zoology" is at least as applicable to the description of the external forms of animals, and the observations of their habits in the field (the true work of the naturalist), as it is to section-cutting in the laboratory; and "Practical Anatomy" would better have expressed the nature of the subject of the present work. Commencing with a general sketch of the scope of biology, the authors take the frog as an example from which to illustrate the structure of animals in general. After treating its anatomy in great detail, they then take a series of animal types to illustrate the gradual progression from the simple to the complex, beginning with the Amœba, and ending with the rabbit. After describing the Monads and Bacteria in one chapter, and the Rotifers and their allies in a second, the Messrs. Parker follow on with Hydra as an example of the Cœlenterata; while the earth-worm does duty for the Annulata, the cray-fish for the Arthropods, and the pond-mussel for the Molluscs; the lancelet, the dog-fish, and the rabbit (in addition to the frog) serving as illustrations for the Vertebrates. A better selection could not have been made; and the extensive experience of both authors in teaching has enabled them to bring into prominence just those points on which the attention of the students should be concentrated. And as the descriptions of the dissections are (with the help of the illustrations) admirably adapted for their purpose, the book should command a large circulation among the zoological students of our science schools.

"The Standard Intermediate School Dictionary of the English Language." By James C. Fernald. (Funk and Wagnalls Co.) This nicely printed school dictionary, with its 800 pictorial illustrations, is an abridgment of Funk and Wagnall's Standard Dictionary. It gives the orthography, pronunciation, meaning, and etymology of about 38,000 words and phrases which are common in the language and literature of English-speaking people. It is already widely used in the schools of America, where it was first published. There are, however, already so many good school dictionaries in this country that we suspect that it is not likely to attain a great popularity with our schoolmasters. A want of precision is exhibited in the meanings assigned to certain scientific terms we have looked up, e.g., "asteroid" is defined as "one of a group of small bodies between Mars and Jupiter," but, as children in secondary schools are more familiar with Roman deities than with the planets, the vagueness of the explanation is likely to cause confusion. Or, again, "basalt" is said to be "an igneous rock of a dark colour and often of columnar structure," but the same thing is more or less true of igneous rocks which no one would call basalts.

"The Makers of Modern Prose: a popular Handbook to the greater Prose writers of the Century." By W. G. Dawson. (Hodder & Stoughton.) 6s. This is the second volume of Mr. Dawson's projected series on the makers of modern English, and it forms in the main an acute and discerning appreciation of some of the makers of modern prose, beginning with Johnson and concluding with F. W. Robertson. The writer appears to have included Froude in his selection for no other reason than to exhibit that unhappy writer as an example to be avoided. He should have been more appropriately included in the last volume of the work, which is to deal with the makers of modern fiction.

"The Natural History of Echinoderms." A Treatise on Zoology. Edited by E. R. Lankester. Part III. The Echinoderma. By F. A. Bather, assisted by J. W. Gregory and E. S. Goodrich. (London: A. & C. Black.) 1900. Cambridge having started a "Natural History" of its own, the sister University has deemed it advisable to enter the same field with a work bearing the more pretentious title of a "Treatise on Zoology," or as the editor would apparently prefer to call it, a "Treatise on Animal Morphography." The Cambridge series is written on somewhat popular lines, while the present one, as is stated in the editorial preface, is addressed to the serious student of zoology. And there can be no question but that the authors of the present volume, which is the first of the series to appear, have treated their subject in a very serious manner indeed. No one but the student who desires to master a very technical subject in all its details is at all likely to be tempted to dip into the pages of the volume before us. For the advanced student of the palæontology and morphology of the Echinoderms (that is to say, sea-urchins, star-fishes, sea-cucumbers, stone-lilies, and their extinct allies) the work seems, however, to be all that can be desired, and will doubtless long remain the standard treatise on the subject. For a "Treatise on Zoology" the present volume is remarkable for the large amount of palæontology it contains; no less than 169 out of a total of 332 pages being devoted to groups which are for the most part entirely extinct. In the case of a group like the Echinodermata (as we prefer to call it) such a treatment was inevitable if the subject was to be made anything like complete; and this bold disregard of popular prejudices affords testimony, if such were required, of the Editor's comprehensive view of the meaning of "zoology." The Echinoderms have indeed suffered almost more severely at the hands of time than any other group of animals that is still strongly represented at the present day; and no proper understanding of the existing representatives of the group can be gained without an intimate acquaintance with the hard anatomy of their fossil predecessors. As we learn from the preface, the series of works is to be written, so far as practicable, by graduates of Oxford; and it is a fortunate circumstance that, while possessing this qualification, Mr. F. A. Bather, in this country at least, is facile princeps in his knowledge of the extinct classes of the Echinoderms. The portion of the work dealing with the Cystids, Blastoids, Crinoids, etc., has accordingly been assigned to him; while he has also written the chapter on Holothurians. On the other hand Dr. J. W. Gregory is responsible for the account of the Star-fishes, Brittle-Stars, and Sea-urchins. A feature of the volume is the number and beauty of the illustrations, which are for the most part original; and an examination of these is alone sufficient to show the extraordinary amount of care and labour the authors have bestowed on their subject. Evidently they had their whole hearts in their work; and the result will contribute in no small degree to the well-deserved reputation they already enjoy. The general classification of the group is the one now usually accepted, save that Dr. Gregory has considered it advisable to brigade the Asteroidea (Star-fishes) and Ophiuroidea (Brittle-stars) in a single class. In this he is no doubt justified, but we question whether linguistic purists will accept the hybrid term "Stelleroidea" as the title for the class as thus extended. In our own opinion it would have been preferable to have employed "Asteroidea" in this sense; designating the sub-classes "Asteroidea Vera" and "Ophiuroidea."

"The Teaching of Geography in Switzerland and North Italy." By Joan Berenice Reynolds. (C. J. Clay & Sons.) 2s. 6d. This little book consists of the report which Miss Reynolds presented to the Court of the University of Wales on her visit to Switzerland and North Italy as Gilchrist Travelling Student, and it has been published because the Executive Committee of the University believe that the information it contains will be of material value to teachers, and to all those interested in education, an opinion in which we heartily concur.

"Journal of Researches." By Charles Darwin. (Ward, Lock.) Illustrated. 2s. Messrs. Ward, Lock and Co. have issued a new and cheap edition of Darwin's Journal of his voyage in the "Beagle," within chaste artistic covers which present a most agreeable appearance, and those with the most slender resources may now add this—one of the immortals—to their collection.

The ever valued Kodak has again evolved a new variety, namely, the 1A Folding Pocket, the mechanism of which is of the familiar "folding-pocket" order, but the size of the picture—$4\frac{1}{4}$ by $2\frac{1}{2}$—is more pleasing.

Entomologists, ornithologists, botanists, and others interested in natural history should have by them a copy of Messrs. Watkins and Doncaster's new Catalogue, which is issued in handy form. Taxidermists' tools, artificial eyes, birds' skins and eggs, cabinets, etc. are entered against figures which will meet with general acceptance.

BOOKS RECEIVED.

Primitive Constellations. Vol. II. By Robert Brown. (Williams & Norgate.) 10s. 6d.

Photo-Relief Map of Africa. (S.P.C.K.) 9d.

Origin and Character of the British People. By Nottidge Charles Macnamara. (Smith, Elder & Co.) 6s.

Alternating Currents. By W. S. Franklin and R. B. Williamson. (Macmillan.) Illustrated. 7s. 6d. net.

Electricity and Magnetism. New Edition. By Silvanus P. Thompson. (Macmillan.) Illustrated. 4s. 6d.

Zoological Results based on Material from New Guinea, Loyalty Islands, &c. Part IV. By Arthur Willey. (University Press, Cambridge.) Illustrated. 21s.

Papers on Mechanical and Physical Subjects. By Osborne Reynolds, F.R.S. (University Press, Cambridge.) Illustrated. 15s. net.

Primeval Scenes. By the Rev. H. N. Hutchinson. (Lamley.) Illustrated. 6s.

The Story of the Alphabet. By Edward Clodd. (Newnes.) Illustrated. 1s.

Journal of the Society of Comparative Legislation. April, 1900. 5s.

Elementary Practical Chemistry. By T. Cartwright. (Nelson.) 2s.

Travels on the Amazon. By A. R. Wallace. (Ward, Lock.) 2s.

Letters of Berzelius and Schonbein, 1836-47. Edited by George W. A. Kahlbaum. (Williams & Norgate.) 3s.

Negritos. By A. B. Meyer. (Stengel, Dresden.)

Note on the Unpublished Observations, 1774-1838, Radcliffe Observatory. By Arthur A. Rambaut, D.Sc., Radcliffe Observer.

THE FIRST MUSK-OXEN IN ENGLAND SINCE THE GLACIAL EPOCH.

By R. Lydekker.

Some persons are unfortunate in their names, and the same is the case with certain animals. The ruminant popularly known as the Musk-Ox and scientifically as Ovibos moschatus is an instance of this, for although no objection can be taken to the prefix "Musk," and its Latin equivalent moschatus, yet the English title "ox" is in the highest degree misleading, while the technical "Ovibos," which suggests characters intermediate between the oxen and the sheep, is equally unsatisfactory. To say that the creature is an animal sui generis would be a truism, seeing that it is the sole existing representative of the genus Ovibos; and yet this expression, perhaps, best conveys the real state of the case, namely, that it is a more or less isolated member of the ruminant group, coming under the designation neither of an ox nor a sheep, nor yet being a connecting link between the two. Under these circumstances it would be much better if the name "Musk-Ox" could be dropped altogether, and (unless it be altogether unpronounceable) its native Greenland equivalent adopted instead. Unfortunately, however, I have hitherto been unable to ascertain by what name the creature is known to the Greenlanders.

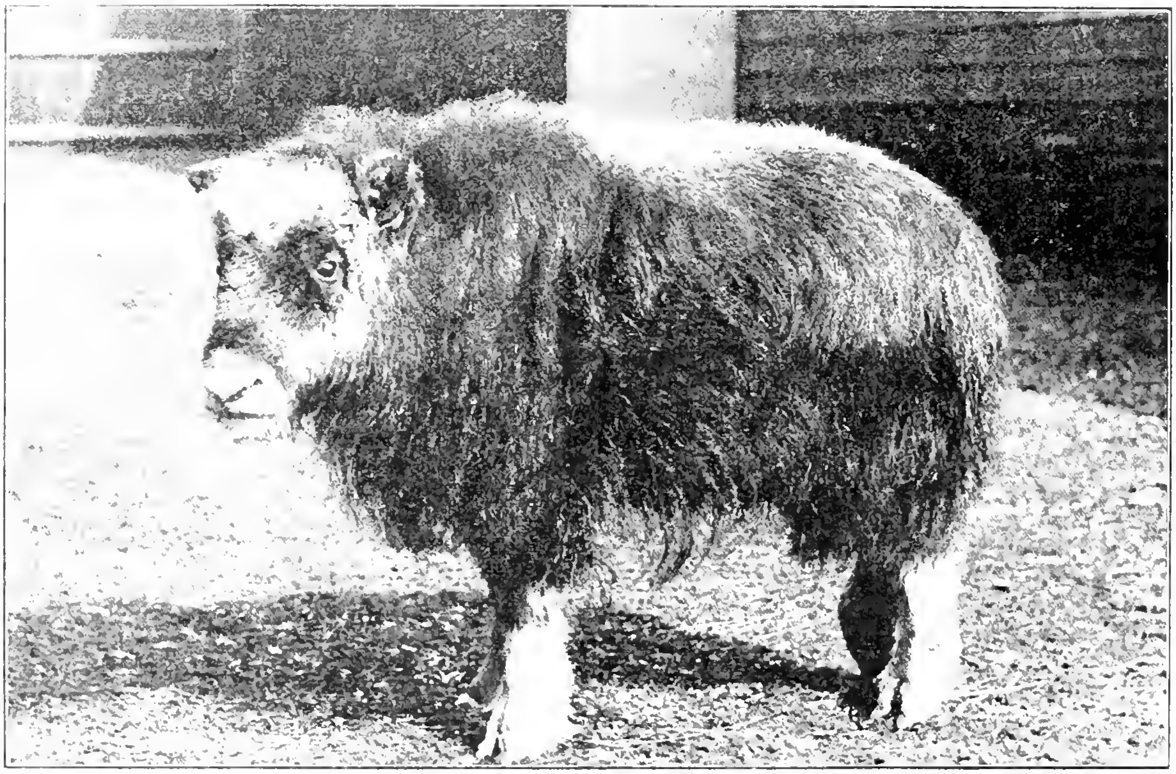
Although now restricted to Greenland and Arctic America eastward of the Mackenzie River, the Musk-Ox was formerly a circumpolar animal, its remains being occasionally met with in the interior of Alaska, more commonly in the frozen cliffs of Eschscholtz Bay, and also in the ice-bound soil of the Lena and the Yenisei valleys. Although unknown in Franz Josef Land and Spitzbergen, the Musk-Ox extends polewards through Parry Island and Grinnell Land into North Greenland, where its northward range is probably only limited by the limits of vegetation. South Greenland at the present day is, however, too hot for such a cold-loving beast, and Melville Bay now forms the southernmost point to which it wanders on the west coast. Consequently it would seem probable that the Musk-Oxen on the west coast are completely isolated from those on the eastern seaboard; the central mountain range of the interior of Greenland being apparently impassable even by such hardy animals, while a transit via Cape Farewell is, as we have seen, barred by climatic conditions of an opposite nature.

In America, however, the Musk-Ox still ranges considerably further south, its limits in this direction being approximately formed by the sixtieth parallel of north latitude; but it is stated that year by year its southern range is slowly contracting—possibly owing to pursuit by man. When the Musk-Ox ceased to be an inhabitant of the Siberian tundra, or why it should ever have disappeared from regions apparently so well suited to its habits as are Northern Asia and Alaska, there are no means of ascertaining. But the date of its disappearance was probably by no means remote, comparatively speaking, and it is even possible that man himself may have taken a share in its extermination. However this may be, it is beyond doubt that the Musk-Ox was an inhabitant of the South of England, as well as of parts of France and Germany, during, or about the time of the glacial epoch; its remains occurring not uncommonly in the gravels of the English river-valleys, such as those of the Thames and Severn, as well as in the brick-earths of Kent. It is also probable that they occur in the "forest-bed" of the Norfolk coast, which somewhat antedates the great glaciation of Britain.

This being so, it is evident that the Musk-Ox was a living British animal within the period during which our islands have been inhabited by man, for in many of the deposits in which its remains occur flint-implements and other evidences of human presence are likewise found. Probably, indeed, the early human inhabitants of Britain not unfrequently made a meal of Musk-Ox beef; but the disappearance of the animal from the British fauna may apparently be attributed rather to a change in climatic conditions than to pursuit by man.

From that long distant day when the last indigenous British Musk-Ox departed this life no living representative of the species appears to have been brought to our islands till the autumn of last year, when a couple of young bulls were added to the collection of the Duke of Bedford at Woburn Abbey. These were captured in August last in Clavering Island, situated off the coast of East Greenland, opposite Konig Wilhelm Land, in about latitude 74.5° N. When they arrived they were about the size of a rather large sheep, but by March of the present year (when the photograph here reproduced was taken) the solitary survivor had increased considerably in size, although the horns are only just becoming visible above the long hair of the sides of the forehead.

Probably most of my readers are more or less familiar with the general appearance of the adult Musk-Ox; but those who are not would do well to turn to its portrait in some work on natural history, or, still better, pay a visit to the British Museum at South Kensington, where both the mounted skin and the skeleton are exhibited. The absence of the large flattened, fibrous, and downwardly curving yellow horns which almost meet in the middle line of the forehead of the adult bull renders the aspect of the head of the calf very different. In other respects, however, the calves are very like the full grown animals in general appearance, showing the same long, straight and rather coarse hair, the conspicuous light-coloured "saddle" on the back, the white "stockings," the woolly triangular ears, the broad and almost completely hairy muzzle, and the entire burying of the rudimentary tail in the long hair of the hind-quarters. Owing, however, to the inferior length of the hair on the flanks, more of the legs is exhibited in the young than in the adult; and this enables the peculiarly heavy and massive form of the pasterns and feet to be better seen. Nothing was more curious about the calves at Woburn Abbey than their movements, which recalled those of a Polar Bear more than those of an ox or a sheep, the hocks being turned outwards in an altogether peculiar and distinctive manner. If this strange gait is also characteristic of the adult, it is probably adapted for progression on glaciers and other ice-coated surfaces; firmness of foothold being secured by the presence of a considerable amount of hair on the under surface of the foot.



YOUNG BULL MUSK-OX. [*From a Photograph by the* DUCHESS OF BEDFORD.

But there is one respect in which the Clavering Island calves differ from the adult specimens exhibited in the British Museum, as well as from the description generally given of the species. This is the presence of a large patch of white hair on the forehead, as well as of an ill-defined white streak down each side of the face, and some scattered white hairs in the middle line between the muzzle and the eyes. When this feature was first noticed, it was thought that the East Greenland Musk-Ox might prove to be a race distinct from the West Greenland and American form, in which the face is, at least in most cases, uniformly dark brown. I have, however, received from Dr. A. G. Nathorst an illustrated account in Swedish of Musk-Ox hunting in East Greenland in 1899; and the photographs in this, although they are unfortunately on a very small scale and by no means distinct, seem to show that while some of the bulls have brown faces, in others there is a considerable amount of white, yet the large frontal patch of white which forms such a conspicuous feature of the calves is, of course, obliterated by the expanded bases of the horns. Accordingly, there seem to be no grounds for separating the Musk-Ox of East Greenland from its representative in West Greenland and Arctic America, although the two would appear to be completely isolated.

To discuss the affinities of the Musk-Ox on this occasion would obviously be out of place; but my readers may probably like to be informed of some of the reasons which preclude its being classed either with the oxen or with the sheep. As regards the horns, it will suffice to say that they are quite unlike those of either of the groups in question. From the oxen the animal is broadly distinguished alike by the structure of its upper teeth, and also by its hairy muzzle. But this broad and hairy muzzle, in which there is a narrow, naked and granular area immediately above and between the nostrils, is equally unlike the narrow and short-haired muzzle of the sheep and goats. In the structure of its upper teeth, as well as in the presence of glands below the eyes and of only two mammæ in the female, the Musk-Ox is, however, much more like the latter group. But these two latter features* are of no great zoological importance, some sheep lacking face-glands, while one species of goat has four mammæ; and they in no wise serve to prove the existence of any close relationship between Musk-Oxen and sheep. It may be added that the aborted tail of the Musk-Ox separates it very widely from the oxen, in all of which this appendage is of great relative length; but in this respect the animal comes nearer to the sheep, nearly all the wild forms of which have short and stumpy tails. In the extremely late development of the horns (as attested by the survivor of the Woburn pair, which must now be at least a year old) the species seems to stand apart from both groups.

Judging from the photographs in Dr. Nathorst's account, it would seem that in East Greenland Musk-Oxen are commonly found in small herds of from eight to nine or a dozen in number. Their favourite haunts seem to be the gently sloping and boulder-strewn short valleys at the foot of the cliffs. Here they can be approached without much difficulty and shot down in the open, the members of the herd standing to gaze unconcernedly at the aggressor after one or more of their number has been shot down. When separated from their mothers, the young calves are by no means difficult to capture. I have been told by a friend that during an expedition to Greenland some officers succeeded in capturing a number of these calves, which they were carrying down on their shoulders to the coast; but the captive animals squealed so loudly as to attract the attention of all the Polar Bears in the neighbourhood, which thereupon started in pursuit and soon induced the unarmed captors to drop their booty!

* The existence of face-glands as well as the normal presence of only two pairs of mammæ has been recently discovered by my friend Dr. Einar Lönnberg, of Upsala.

CHEMICAL EVOLUTION.

A CHAPTER OF HISTORY.

By G. Cecil Fry.

The whirligig of time brings its revenges, and the fanciful speculations of chemists about the elements, from the time of Prout onwards, have in recent years found confirmation in a science which no chemist of fifty years ago could imagine as having any relation to chemistry. Astronomy has contributed solid facts to what was merely an attractive theory; and the spectroscope, by which this result has been brought about, is an instrument equally important to both sciences.

There have been always scientists to whom the notion of sixty or seventy distinct kinds of matter was unthinkable. Ancient philosophers conceived all the manifold varieties of matter as but different manifestations of one "first matter," or protyle. The old division of matter into four "elements" was physical rather than chemical. The so-called elements were states or conditions of matter, not matter itself. The idea of "protyle" survived long in the minds of alchemists, but, after a period of oblivion, it was introduced to modern science with a new and special meaning.

In 1815 there appeared in the "Annals of Philosophy" an anonymous paper on the relations between specific gravities and atomic weights. The following sentence occurs in this paper: "I had often observed the near approach to round numbers of many of the weights of the atoms before I was led to investigate the subject."

This was merely a statement of fact or supposed fact; but in the next volume of the "Annals" a second paper on the same subject appeared, containing a full-fledged hypothesis. The following is the most notable part of the paper: "If the views we have ventured to advance be correct, we may almost consider the protyle of the ancients to be realised in hydrogen; an opinion, by the-by, not altogether new. If we actually consider this to be the case, and further consider the specific gravities of bodies in their gaseous state to represent the number of volumes condensed into one; or, in other words, the number of the absolute weight of a single volume of the first matter, protyle, which they contain, which is extremely probable, multiples in weight must always indicate multiples in volume, and vice versa; and the specific gravities or absolute weights of all bodies in a gaseous state must be multiples of the specific gravity or absolute weight of the first matter, protyle, because all bodies in a gaseous state which unite with one another unite with reference to their volumes."

This, then, was "Prout's hypothesis," as it was called when the identity of its author became known. It supposes, in brief, that the elements have been formed by successive condensations or polymerisations of hydrogen, the protyle from which all other forms of matter are derived.

Prout's idea was taken up with enthusiasm by Thomas Thomson, Professor of Chemistry at Glasgow. He supported it by a series of experiments which was probably the worst quantitative work ever published in chemical literature. Berzelius reviewed Thomson's results in 1827, and hinted very plainly that the experimental part of the work had been done at the writing desk; in other words, that Thomson had deliberately "faked" his figures in support of an untenable theory. This was doubtless untrue, but certainly Thomson's results were grotesquely inaccurate, and his experiments were carelessly performed by bad methods.

The atomic weight determinations of Berzelius appeared to have settled Prout's hypothesis altogether in the negative. But, in 1840, Dumas discovered that the great Swedish chemist had made a serious mistake in the atomic weight of carbon, which he found to be 12·2. Dumas found it to be almost exactly 12, and became in consequence strongly prepossessed in favour of Prout's hypothesis. His atomic weight determinations were done in the expectation of confirming it. The case of chlorine, however, seemed irreconcilable, and Marignac suggested a protyle having half the atomic weight of hydrogen as the unit of atomic weights. This was the first appearance of the modified or "elastic" Prout, as it has been sarcastically named. A little later, Dumas proposed one-quarter of the atomic weight of hydrogen. Someone suggested ether as the hypothetical protyle, and gave it an atomic weight of .0001, a figure which is, of course, quite beyond the reach of analytical chemistry.

A theory that is being continually changed like this needs no disproof: but the magnificent work of Stas was destined to give the death-blow to both the original and the elastic Prout, as far as it could be given by exact analysis. Yet Stas himself began his work as a firm believer in Prout. He wrote:—"When I began my researches, I had an almost absolute confidence in the exactness of Prout's Law." His "absolute confidence" soon vanished, and he afterwards described the hypothesis as a pure illusion.

In a paper on the atomic weight of aluminium, published in 1880, Mallet criticised Stas' work on the ground that, though accidental errors had been practically abolished, there might still remain undetected constant errors. This is highly improbable, considering the variety of methods used by Stas; and, even if true it would prove little or nothing. For while the detection of a constant error may bring one element nearer the required value, it is just as likely to take another element farther away from it. Oxygen is a case in point. Since the date of Mallet's paper it has fallen out of the list of elements whose atomic weights are approximate whole multiples of that of hydrogen. The work of Keiser, Cooke and Richards, Rayleigh, Scott, Morley and others, leaves little doubt that the atomic weight of oxygen is less than 15.9, and is probably very near to 15.88.

There is nevertheless a real and striking approximation of many atomic weights to whole multiples of that of hydrogen. In the paper already referred to, Mallet gave a list of eighteen elements whose atomic weights have been most accurately determined. Ten of those atomic weights were within 0.1 of whole numbers. (As already stated oxygen has fallen out of this list.) The chances against this occurring accidentally are more than 1,000 to 1. F. W. Clarke extended this argument to sixty-six elements, of which forty have atomic weights falling within the 0.1 limit of variation. He says that forty agreements include nearly all the trustworthy determinations.

The case seems to stand thus:—Prout's hypothesis in its original form, and in the modifications proposed by Marignac and Dumas, is untrue. But there is, nevertheless, a certain approximation to it, which is scarcely likely to be quite accidental.

All this, however, does not really affect the wider question, whether the elements are primordially distinct bodies, or whether they are derived by aggregation from a simpler form or forms of matter. For a long time there was only negative evidence on both sides; but for a good many years now positive evidence has been accumulating in favour of the evolution of the elements.

To begin with, the only evidence in favour of the elementary nature of the elements is purely negative. The definition of an element is based, not on any attribute of the thing defined, but on the limitations of human power. It is merely a confession of impotence.

The progress of science is, in general, a process of simplification. Larger and larger groups of facts are brought under more and more general laws. Thus chemists have, during the last two centuries, reduced the millionfold chemical complexity of heaven and earth to, say, a seventyfold complexity. Is there to be at this point a solution of continuity, or is the simplification to go on to its logical conclusion?

Physics, it may be noted, takes small account of chemical differences. All forms of matter alike obey the laws of physics in the same way. Graham, who was both physicist and chemist, was strongly impressed by this physical unity underlying chemical diversity. He wrote in 1863:—"It is conceivable that the various kinds of matter, now recognised as different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement. The essential unity of matter is an hypothesis in harmony with the equal action of gravity on all bodies."

Again, the relations between the atomic weights of the elements render their complete independence of one another hardly supposable. The greatest generalisation made in chemistry since the atomic theory is "the properties of the elements are functions of their atomic weights"; and the prediction of the properties of gallium, scandium and germanium was a greater triumph to chemistry than was the prediction of Neptune to astronomy.

The work of Sir William Crookes on the rare earths is of the highest significance. He has shown that a substance like yttrium, which from every chemical point of view behaves as an element, can by repeated fractional precipitations be split up into several groups having different spectra, and presumably different atomic weights. The process of fractionation implies differences among the "elementary" atoms, and a possibility of selection. Crookes writes thus about didymium, after splitting it up into neodymium and praseodymium:—"Didymium is certainly a compound. It has a definite atomic weight and well-defined salts, and has been closely scrutinised by some of the ablest chemists in the world. But it emerged as a seeming element from every trial."

The distribution of the elements in the earth also deserves consideration. How can this be explained apart from the theory of evolution? Why, for instance, should nickel and cobalt be always found together? Why should the platinum group of metals and the rare earths be so localised and so rare? Why should meteoric iron always contain nickel and cobalt, and very often manganese and chromium as well—all elements of similar properties, and nearly equal atomic weights? These facts are just what one would expect if these elements had been formed under nearly identical conditions from simpler forms of matter.

The remainder of the evidence is more positive in character, and is chiefly due to the spectroscopic researches of Sir Norman Lockyer. So long ago as 1876, Lockyer showed that the spectrum of calcium varies at different temperatures, and that the changes brought about by rising temperature are exactly parallel to the changes in the spectrum of a compound as it is gradually dissociated by heat. In short, this element behaves, spectroscopically speaking, as a compound.

The spectrum of iron is well known to be enormously complex; and it ought to be noticed, in passing, that this complexity is in itself some evidence against the elementary nature of iron; it is difficult to imagine an indivisible atom vibrating in so many hundreds of different ways. But the iron lines in the solar spectrum differ in many ways from those in the terrestrial spectrum. Lockyer has found that on certain days certain lines are absent; on other days other lines; and so on in almost endless variety. The lines of a sun-spot are different from those of a prominence. Some of the iron lines may be bent, indicating rapid motion of the luminous material, while other lines in the same spectrum remain straight, indicating comparative rest. The lines indicating motion vary from place to place and from day to day. The set of bent lines in a sun-spot is different from the set of bent lines in a prominence. In short, an indivisible atom can move and remain at rest at one and the same time! The only feasible explanation of these facts seems to be that the iron has been dissociated by heat, and that the constituents have been partly separated.

The idea that each substance has a spectrum entirely and specially its own is untrue. Many lines of different metals coincide. Thus out of sixty-two lines of iron in the region 39 to 40, no less than forty-four coincided with lines of other metals.

It has also been shown that many elements have fluted as well as line spectra. The former are characteristic of low temperatures. As the temperature rises, the lines appear one by one. The series of spectra so obtained is exactly parallel in appearance with the series obtained when a known compound is dissociated by heat. There is a gradual thinning-out of bands and appearing of lines.

The witness of the stars to elementary evolution is much more striking and direct. Lockyer, long ago, pointed out in a general way that the hottest stars have the simplest chemical composition, and he has recently developed this subject much more fully. In a lecture delivered in the spring of last year he said:—"Dissociation reveals to us the forms the coming together of which has produced the thing dissociated or broken up by heat. If this be so, the final products of dissociation or breaking up by heat must be the earliest chemical forms. Hence we must regard the chemical substances which visibly exist alone in the hottest stars as representing the earliest evolutionary forms."

The lecturer then gave details concerning the increase of chemical complexity in stars with decrease of temperature:—"We find that in the hottest stars we get a very small number of chemical elements; as we come down from the hottest star to the cooler ones the number of spectral lines increases, and with the number of lines of course the number of chemical elements. In the hottest stars of all, we deal with a form of hydrogen which we do not know anything about here (but which we suppose to be due to the presence of a very high temperature), hydrogen as we know it, the cleveite gases, and magnesium and calcium in forms which are difficult to get here; we think we get them by using the highest temperatures available in our laboratories. In the stars of the next lower temperature we find the existence of these things continued in addition to the introduction of oxygen, nitrogen and carbon. In the next cooler stars we get silicon added; in the next we get the forms of iron, titanium, copper, and manganese, which we can produce at the very highest temperatures in our laboratories; and it is only when we come to stars much cooler that we find the ordinary indications of iron, calcium and manganese and other metals. All these, therefore, seem to be forms produced by the running down of temperature. As certain new forms are introduced at each stage, so certain old forms disappear."

This chain of facts, thus briefly stated, confirms in a most striking way the chemical speculation that has been going on more or less continuously since the time of Prout; and gives solid support to the theory of the evolution of the elements. The only mistake that Prout made—a very natural mistake at the time—was in taking hydrogen as his starting point. For if evolution of the elements has really taken place, some modification of Prout's hypothesis must be true. The atomic weights of the elements must be multiples of that fraction of hydrogen which may result from the dissociation of hydrogen. The fact that the verification of this is beyond the reach of analytical chemistry is beside the question; but it is worth noting that some of the most accurate atomic weight determinations ever made were due to the controversy over Prout's hypothesis, which has, in this way, at least, borne practical fruit.

It has long ago been noticed that the essential elements of living matter are all of relatively low atomic weight. Sir Norman Lockyer has also pointed out the interesting fact that these elements are precisely those found in the hottest stars. In other words, organic evolution began among the earliest and simplest chemical forms; and the marvellous mobility and plasticity of the protoplasmic cell are due to its being formed from the simplest, and, presumably, the most mobile and most plastic of the elements. We have here "a quite new bond between man and the stars."

Before biological evolution could begin, there was a chemical evolution like it in many respects, characterised by the same progress from simplicity to complexity, by the appearance of new forms and the disappearance of old ones. As the rocks are divided into strata according to the fossils they contain, so the stars can be divided into "strata" according to their chemical composition and the period of evolution they have reached.

This chemical evolution comes very exactly under the philosophical definition of evolution in general. It is a progress from "an indefinite, incoherent homogeneity to a definite, coherent heterogeneity."

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

The residua and strainings obtained from ordinary tap water will provide the microscopist with an abundance of material for examination. Among the organisms that he will probably meet with are the fat little rotifer, *Triarthra longseta*, hobbling along on his long delicate stilts in company with the pretty little long-spined *Anuraea longispina*. The Vorticellidae and Entomostraca are often in great force, with diatoms and desmids innumerable. *Dinobryon sertularia*, a curious compound flagellate organism, like animated ears of barley, though not so numerous, are invariably present in greater or lesser numbers. A bag made of several thicknesses of very fine muslin and tied on the water tap, so that the water strains gently through it, is a rough and ready, but, on the whole, a satisfactory way of capturing them.

A practical way for obtaining crystals from dog's blood is suggested by Dr. S. Waterman. Defibrinate and mix water in equal parts to each volume of blood. Add to four volumes of the blood solution one volume of alcohol. Set the mixture to rest for twenty-four hours at a temperature of 0° or less. The crystals formed are filtered off, pressed, dissolved in the smallest quantity of water, say 25 to 30 per cent., exposed to a temperature of 10°, and left undisturbed for twenty-four hours. The whole solution will be found converted into a crystallised mass.

The production of haemoglobin crystals is surrounded at times with more or less difficulty, owing to the rapidity with which the haemoglobin decomposes. A simple method is to allow the blood to coagulate, express the serum, and separate the fibrin by filtration. Through this solution pass a current of oxygen for half an hour, and then carbonic acid gas for ten or fifteen minutes. Crystals may be readily obtained from the blood of the dog and other animals by adding alcohol in small quantities during the passage of the gas currents.

Sunlight is par excellence the best source of illumination for photomicrography. A good substitute for a heliostadt is a fair-sized mirror swinging on a double axis, and capable of being regulated by hand. No difficulty is experienced in keeping the light centred, as exposures by sunlight are of such short duration. When using sunlight, care should be taken to pass the rays through a cell of saturated solution of alum, in order to absorb the heat rays, otherwise serious damage may be done to the objective and the sub stage condenser.

After sunlight, diffused daylight from a window with a northern exposure is the next best light at the disposal of the photo-microscopist, but when it is necessary to use artificial illumination, acetylene gas or magnesium wire will be found to give satisfactory results. Some objects are better shown under a diffused light, such as may be obtained by the interposition of a ground-glass screen, or near a window without the aid of a condenser. If the colour of the object be dark, or reflects but little light, the bull's eye should be focussed on the specimen, care being taken to avoid glare or excess of illumination, which will result in a confused image in the negative. With some objects, the Lieber kuhn may be used advantageously, with others the parabolic reflector, but the majority yield better results under the most simple forms of illumination.

Potato-agar is suggested as a good cultivating medium for thermophilous bacteria. It is prepared as follows:—Potatoes are steamed, peeled, and pounded. To 100 grammes of potato add one litre of water, steam the mass for half an hour and then filter. To the filtrate add two per cent. of agar and autoclave the whole for fifteen minutes. It has been found advantageous to add one per cent. of salt. After neutralization with soda, and further steaming, filter the potato-agar into test tubes and sterilize once more.

To prepare photo-micrographs of diatoms, first photograph the diatoms with a magnification of not more than 100 diameters, then enlarge so as to obtain a photograph of 500 diameters, proper for photo-printing. The finest details are thus brought out, which otherwise are invisible to the eye in the smaller photograph. Even forgeries in legal documents can be discerned by using enlargement pictures, which microscopically are not visible if printed on bromide or velox paper.

Magnesium as an illuminant for photo-micrography is not a new idea. It was used for this purpose by Dr. R. L. Maddox as far back as 1864, but owing to the expense of its production it never became really popular. Magnesium is prepared commercially from the melted chloride of electrolysis, or by metallic sodium, and, when heated either in air or oxygen it first glows and then burns with a bluish-white dazzling flame. The experiments of Bunsen and Roscoe have shown that the sun at its zenith has only 36·6 times more chemical brightness, and 524·7 times more visual brightness than magnesium. It is therefore suitable in a special degree for photographic purposes, and now that the price of the metal, either as bar, wire, ribbon, or powder is so low, there is every inducement to the photomicrographer to call in its aid.

The following method of preparing sections of the teeth of fish is suggested by Mr. A. Underwood, of the Leicester Square Dental Hospital. Sections of fishes' teeth should not be ground, but the jaws and teeth should be decalcified in a 5 per cent. solution of chromic acid, or a 10 per cent. solution of hydrochloric acid. After sections have been cut and stained, they should be well washed in distilled water, dehydrated for three minutes in absolute alcohol, cleared in oil of cloves, and mounted in Canada balsam. Carmine is the best stain for fishes' teeth.

In collecting any fleshy fungi, care should be taken to obtain all the fleshy structure, as some of the most important characters are only to be observed in the basal parts. To remove the basal portion entire, a knife or small trowel should be employed. Specimens that are broken off short with the ground are seldom of much value for scientific purposes. Fleshy ascomycetous fungi can best be preserved in alcohol, but many of them may also be satisfactorily dried. It is well, when fungi gathering, to take a stock of tissue paper to wrap the specimens in. Each form should be wrapped up separately so as to prevent breaking, or soiling from contact with one another.

A good dead black for varnishing the interior of microscope tubes and cameras may be made by mixing two grains of lamp-black with just enough gold size to hold the lamp-black together. Add the size drop by drop from a lead pencil. After the lamp-black and size are thoroughly mixed and worked up, add twenty-four drops of turpentine and work up again.

To the current issue of the journal of the Quekett Club Mr. A Earland contributes an interesting article on the structure, distribution and life-history of the Radiolaria, illustrated by three plates from the Report on the Radiolaria of the "Challenger" Expedition.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* KNOWLEDGE.]

NOTES ON COMETS AND METEORS.

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

GIACOBINI'S COMET.—This object is now about 7 degrees south of the star Beta Andromedae, and is moving to the north-west. It is rapidly becoming more favourably situated, and is approaching the earth. The twilight is now, however, very strong, and the comet being a faint one, a powerful telescope must necessarily be employed in its observation. The comet will be presented under its best aspect during the absence of moonlight in the last half of July. At the middle of that month the apparent brightness of the object will be about twice that at discovery on January 31. In February the comet was of the 13th magnitude, and described as a somewhat difficult object on account of its faintness by several of the observers who were fortunate to obtain views of it. The following is an ephemeris of the comet by A. Berberich (Ast. Nach. 3636):—

Date.	R. A. h. m. s.	Dec. ° ′	Distance in Millions of Miles.
June 2	1 3 53	+ 28 36	174
" 6	0 57 49	+ 30 11	167
" 10	0 50 40	+ 31 52	161
" 14	0 42 9	+ 33 39	155
" 18	0 31 59	+ 35 31	148
" 22	0 19 43	+ 37 29	140
" 26	0 4 50	+ 39 31	134
" 30	23 46 53	+ 41 32	128
July 4	23 25 11	+ 43 27	122

COMET DISCOVERERS.—The close of the last century terminated the interesting and numerous series of cometary discoveries effected by Miss Caroline Herschel, and by Messier and Mechain. But Pons very shortly afterwards came into the field and eclipsed all the efforts of his predecessors in this productive line of work. Originally a door keeper at the observatory at Marseilles, the instruction and encouragement he received from the director Thulis (discoverer of Encke's Comet at its return in 1805), resulted in his taking up the search for comets, and his perseverance and genius for the work enabled him to make a remarkable number of discoveries. Now, at the close of the nineteenth century we have many successful comet hunters, including Brooks, Swift, Perrine, and Giacobini. Among those who have earned special distinction in this branch during the last half of the century are Tempel, Winnecke, Donati, and Klinkerfries, who have "gone over to the majority." Others including Barnard, Borelly, Coggia, H. P. Tuttle and a few others of less renown are still living though engaged in other astronomical work. When the history of cometary discovery in the nineteenth century comes to be written due praise will be given to Pons, Tempel, Brooks, Barnard, Swift, and Winnecke, who have proved themselves the most successful workers in this attractive and exciting field.

THE APRIL METEORS.—The weather was clear and the evening sky moonless at the epoch of this shower, but it did not return in any strength. Meteors generally were rare—a characteristic of the Spring season—and the Lyrids only reappeared in sufficient numbers to prove their existence. Prof. A. S. Herschel watched the sky at Slough for short intervals on April 15, 16, 17 and 18, and during an aggregate of 7 hours of observation only recorded 7 meteors. On April 19 he saw 12 meteors in $4\frac{1}{2}$ hours. On April 20, 25 meteors in 5 hours, and on April 21, 35 meteors in $4\frac{1}{4}$ hours. The true cometary Lyrids from a radiant at $270° + 32°$ were in very weak evidence, only 3 or 4 being seen, while about 12 were from a good radiant at $277° + 30°$. Outlying radiants were in Draco and Lyra at $261° + 18°$ and $280° + 47°$, comprising between them 15 or 20 fine streaked meteors. Mr. A. R. Hinks at Cambridge watched the sky for several hours on April 20, but saw no Lyrids, though a definite shower appeared to be proceeding from the region of Beta Draconis. Mr. A. King at Leicester made observations on several nights and registered a number of meteors, but there were only a few Lyrids and these showed a radiant at 274° + 33°, being a little east of the usual position, and confirming fairly well Prof. Herschel's centre at 277° + 30°. As the radiant is probably a morning one the mean of the two positions would nearly represent its usual place on April 21, but would be several degrees east of its position on April 19. In observations of this and similar showers it is therefore of great importance to keep the observations for each night separate, and determine the individual radiants for successive dates if there are sufficient materials for the purpose. This is, however, not often the case, as the Lyrids form a very short lived shower, and one very meagre in the distribution of its meteors. They are usually rare except on the night of maximum, and even then the shower is so poor as to be scarcely distinguishable. Two meteors of the display appear to have been doubly observed this year. On April 20 at 10h. 19m. a small meteor of about 4th mag. was recorded by Prof. Herschel at Slough, and by Mr. H. Corder at Bridgwater. The former found the radiant from the combined tracks was at 257° + 40°, and the heights from 34 to 30 miles over a point N.W. of Basingstoke, Hants. The elevation is unusually low, but there seems little doubt as to the identity of the objects. A meteor which appeared on April 21 at 10h. 32m. of 3½ magnitude, was seen by Prof. Herschel and by Mr. A. King at Syston, near Leicester. Prof. Herschel places the radiant in 180° − 25°, and gives the heights of the meteor as from 65 to 55 miles from over Woodstock to near Leicester. The path was 54 miles long, and the speed about 15½ miles per second, which agrees very well with the theoretical velocity, which would be 15 miles per second.

Fireball of March 28.—A magnificent meteor was seen on March 28 at about 8h. 32m. by Mr. Astbury at Wallingford, Mr. Crommelin at Blackheath, Mr. G. T. Davis at Reading, Mr. Knight, Bishop's Stortford, and other observers. It was several times brighter than Venus, and lit up the sky with a vivid flash. Prof. Herschel has discussed the observations and finds the radiant at 182° + 43°, and heights of from about 60 to 35 miles over the S.E. part of England. The observations, however, disagree in some essential particulars, and it does not seem possible to derive a perfectly satisfactory result from them. A few additional descriptions of this fine meteor would be very valuable, and it is to be hoped that they will be forthcoming.

THE FACE OF THE SKY FOR JUNE.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 3.51 and sets at 8.5; on the 30th he rises at 3.48 and sets at 8.19. The sun enters Cancer, and Summer commences at 10 P.M. on the 21st. Sun spots are still occasionally to be seen.

The Moon.—The moon will enter first quarter at 6.59 A.M. on the 5th; will be full at 3.39 A.M. on the 13th; will enter last quarter at 0.57 A.M. on the 20th; and will be new at 1.27 A.M. on the 27th. Among other occultations during the month, that of Saturn, on the 13th, will be of special interest. Particulars of the three occultations visible at Greenwich are given below:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
							°		d. h.
June 2	κ Cancri	5·0	8.33 P.M.	120	82	9.35 P.M.	287	247	5 6
„ 7	D.M. − 1°·3570	6·0	9.58 P.M.	156	135	10.55 P.M.	251	222	10 7
„ 13	Saturn		9.30 P.M.	89	116	10.52 P.M.	245	283	16 7

There will be a partial eclipse of the moon, beginning just before it sets on the morning of June 13th. The magnitude of the eclipse is 0.001, and the moon is only in the shadow proper for about 7 minutes. First contact with the shadow takes place at 3.24 A.M., and last at 3.31 A.M., the moon setting at 3.54 A.M. The shadow will fall on the lower part of the moon, to the left.

The Planets.—Mercury is an evening star, but at this season one can scarcely expect to observe him.

Venus is an evening star and attains her greatest brilliancy on the 1st. The planet will be stationary in Gemini on the 16th, after which it will rapidly approach the sun and be lost to our view until it reappears as a morning star. On the 15th one seventh of the disc will be illuminated.

Mars is a morning star, but as it rises less than two hours before the sun during the greater part of the month no further data need be given.

Jupiter is fairly well placed for observation from dusk until the early morning hours. His path is a short westerly one in Scorpio, and at the end of the month will be very near to Beta Scorpii; on the 30th he will be 1½ minutes following and 18′ south of the star. The apparent diameter on the 15th is 41″.6, and the meridian passage on the same date is at 10.32 P.M. The satellite phenomena are most interesting, at convenient hours, on the 1st (8.19–11.0), 3rd (9.35–11.56), 4th (8.14–10.45), 8th (10.33–12.58), 11th (8.27–12.43), 17th (10.26), 18th (10.13–12.57), 19th (10.43), and 29th (9.49–10.58).

Saturn is visible throughout the greater part of the night, rising about 9.30 on the 1st, and about 7.30 on the 30th. He is in opposition on the 23rd. On the 13th the planet will be occulted by the moon. During the month the planet describes a westerly path between Mu and Lambda Sagittarii. On the 19th, the diameter of the ball is 17″, while the outer major and minor axes of the outer ring are respectively 42″.6 and 18″.9. The northern surface of the ring is visible.

Uranus is in opposition at 11 A.M. on the 1st, when he rises at 8 P.M. During the month he describes a short westerly path in the south-western part of Ophiuchus, a little to the south east of the star Omega in that constellation.

Neptune is not observable, being in conjunction with the sun on the 18th.

The Stars.—About 10 P.M. at the middle of the month Cygnus will be in the east; Lyra will be high up, a little to the south of east; and Aquila will be in the same direction but lower. Near the meridian will be Hercules, Corona, Ophiuchus, Libra, and Scorpio. Arcturus will be a little west of the meridian, Virgo rather low in the south-west, and Leo almost due west.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of May Problems.

No. 1.
(N. M. Gibbins.)
1. Kt to K5, and mate next move.

No. 2.
(W. Clugston.)
1. B to Kt1, and mate next move.

Correct Solutions of both problems received from W. de P. Crousaz, Alpha, G. A. Forde (Capt.), J. Humble, J. W. M. ..., G. W. Middleton, J. Baddeley, W. F. Denning, W. Clugston, H. C. Jellman.

Of No. 1 only, from Otto Schachel.

Of No. 2 only, from D. D., A. Gorham.

D. D.—Kt × P will not solve No. 1.

A. Gorham.—If 1. Kt to K3, Q × Q, and there is no mate.

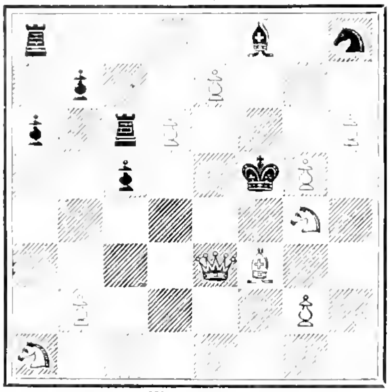
Otto Schachel.—None of your solutions to No. 1 will work. Black's best defence must be assumed in every case.

W. Clugston.—Many thanks. You will see that Mr. Gundry's problem appears below.

PROBLEMS.

No. 1.
By B. G. Laws.

Black (8).

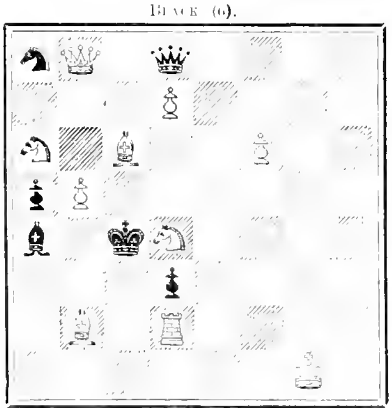


White (10).

White mates in three moves.

No. 2.
By W. H. Gundry.

Black (6).



White (10).

White mates in two moves.

CHESS INTELLIGENCE.

The Anglo-American inter-universities cable match has resulted in a decisive win for the English universities. The score was as under:—

England.		America.	
Tattersall (Camb.)	½	Rice (Harvard)	½
Sottlaw (Camb.)	1	Hunt (Princeton)	0
Edis (Oxon.)	1	Sewall (Columbia)	0
George (Oxon.)	1	Cooke (Yale)	0
Soddy (Oxon.)	0	Hopkins	1
Wiles (Oxon.)	1	Austell	0
	4½		1½

The Paris International Tournament is just beginning as we go to Press. The entries include Lasker, Pillsbury, Maroczy, Janowski, Schlecter, Brody, Burn, Mason, Tchigorin, and about twelve others, including perhaps Blackburne.

The death of Rudolph Charousek deprives the world of a brilliant player who might easily have risen to the championship. Before his death, at the age of 27, most judges would have placed him among the first five living players. Charousek won the Berlin tournament and was second to Tchigorin at Budapest, and to Burn at Cologne, the last tournament in which he took part.

The Hastings Chess Festival was brought to a successful conclusion last month. Messrs. Blackburne, Lee and Teichmann were the masters engaged, five drawn games being the result of their consultation games. Mr. Teichmann's simultaneous performance resulted in a score of 15 wins and 5 draws out of 20. Mr. Blackburne, blindfold, was also in excellent form, winning 5 games and drawing one. In the duplicate series of consultation games Mr. Teichmann made the best score, winning both his games, while Messrs. Blackburne and Lee won one and drew one.

After an adjournment over Easter the City of London invitation tournament was brought to a conclusion with the following score:—

R. Teichmann	9½	First prize	£20
J. Mason	9	Tie for second and third prizes	£12
I. Gunsberg	9		£12
W. Ward	8½	Fourth prize	£8
L. Van Vliet	8	Fifth prize	£6
J. H. Blackburne ...	7½	Sixth prize	£4
T. F. Lawrence... ...	6	Seventh prize	£2
F. J. Lee	5		
R. Loman	4½		
A. Tietjen	4		
E. O. Jones	3½		
T. Physick	2		
S. Passmore	1½		

Messrs. Teichmann and Mason both started badly. Mr. Blackburne, on the other hand, secured a good lead at the start, but after the adjournment was severely handicapped by illness. Mr. Ward is to be congratulated on an excellent performance; to be one point only behind the first prize winner is a most creditable achievement in such company. Mr. Gunsberg showed that he has lost little of his former skill, though he retired from serious chess some years ago. Mr. Loman, on the other hand, has done better things in his time.

The annual tournament of the Southern Counties' Chess Union will be held this year at Bath, the date fixed being September 3 to 12. The Scottish Association tourney has resulted in a tie between Mr. D. Y. Mills, the perennial holder of the trophy, and Dr. Macdonald; the tie is to be played off during the summer. The championship of the Southern Counties Chess Union has again been won by Surrey, who defeated Gloucestershire in the final tie.

For Contents of the Two last Numbers of "Knowledge," see Advertisement pages.

KNOWLEDGE

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THE TOTAL SOLAR ECLIPSE OF MAY 28, 1900.

By E. WALTER MAUNDER, F.R.A.S.

IN one important respect the total eclipse successfully observed in January, 1898, differs from that successfully observed in May, 1900. The first had its sunrise and sunset limits in the inaccessible regions of Central Africa and Western China respectively. Its central or midday portion, however, lay across the Peninsula of Hindustan, so that the observers were comparatively speaking massed together, and their conditions either of time or weather did not greatly differ from each other.

The latter eclipse, on the other hand, had its high noon in mid Atlantic, where there was no convenient island lying in the track from which observers might view the eclipse high in the sky and with the greatest total phase. The observers had perforce to go either to the extreme west, where the shadow track lay across the southern states of North America, or to the extreme east, where stations were available on the *terra firma* of the Peninsula or the northern states of Barbary. Though the sun was in no case very high, and the periods of totality were short, we have in the eclipse just past —since the shadow passed through clear weather from Mexico to Tripoli—the great advantage of being able to compare results, both coronal and spectroscopic, obtained before and after the interval of a few hours. This comparison will be of the utmost value in deciding many points as to the slow or rapid change in the form and direction of the coronal filaments and streamers, but naturally some weeks must elapse before such comparison can be made, and at the moment I can speak only of the observations secured in Algiers and the neighbourhood.

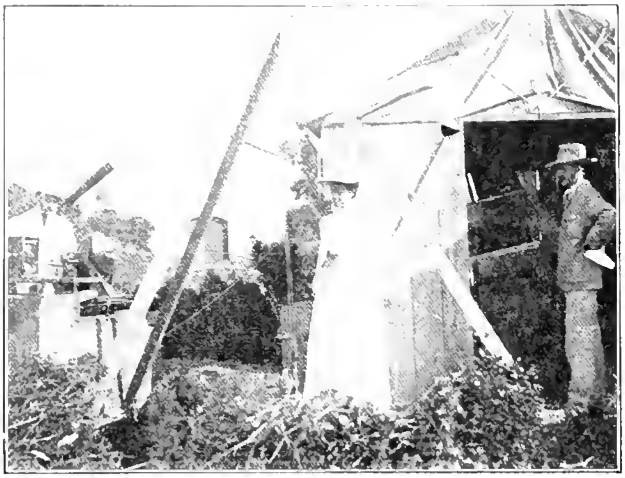
All eclipse observations tend to take on a routine character, and rightly so. No fact, either in the form or the spectrum of the corona, can be completely worked out from the observations of a single eclipse, or even three or four eclipses. Thus, though we may not now expect to make any very startling discovery from the medium-sized photographs of the inner corona, or even from the very large scale ones, yet it is necessary that these should be taken regularly and in considerable numbers at each eclipse. It is from the permanence or the variation in their minor details that it will be ever possible to learn the nature of the structure of the corona. Of their value, even when it comes to prophesying the coronal form, an instance may be taken from the present eclipse. From the coronal photographs of 1898 it was strongly suspected that there was an intimate relationship between the great coronal streamers and the prominences; these lying at the base of the great synclinal curves, and apparently modifying the form and nature of the corona in their immediate neighbourhood. Though this could not be proved to be more than a suspicion it was sufficient for us, when Mr. Evershed telegraphed to us from Pont Mazafram on the morning of the 28th that there was a large prominence in position angle 226°, to warn Mr. Wesley and those other observers who were intending to draw in detail a small portion of the corona in the telescope, that this region was probably the base of a great ray. The event justified the prophecy, and Mr. Wesley, Mr. Crommelin and Miss Leake have examined with great particularity this part for comparison with the photographs of the base of the great ray.

So, too, it will be necessary to continue the observations of the spectrum of the "Flash" and of the corona, both with the slit spectroscope and with the object-glass prism, even though we may not expect them to differ in any important particular from those that have been taken at previous eclipses.

Apart from these regular and routine observations, several strong efforts have been made in the 1900 eclipse to push forward enquiries in various directions into the nature and form of the sun's surroundings.

Of these, the most important are the attempts of Sir Norman Lockyer and of Mr. Evershed, by different methods, to gain a more intimate and detailed knowledge of the spectrum of the "Flash." Sir Norman Lockyer took his station on the central line in the ordinary way, and relied for his success on the use of a longer focal length and consequently a larger image of the sun with his objective prism than has ever yet been employed. He was favoured by very clear skies, and his telegrams have announced the general success of his photographs. How far he has been successful in his special object of finding to a more minute degree the level or levels, above the sun's surface of the gases which give the spectrum of the "Flash," it must of course be many weeks before we can know.

Mr. Evershed conceived a bolder plan, which proved successful in all but one vital point, for which indeed Mr. Evershed cannot in any way be held responsible. Forsaking the central line with its many seconds of totality, he took his station near the edge of the shadow, where as he hoped his total phase would be reduced to some 20 or 25 seconds. His object was two-fold; to get a rolling or grazing contact of the limbs of the sun and moon whereby the "Flash" would be given out all along the osculating surface; and to get the "Flash" not near the sun's equatorial regions, as do the observers on the central line, but at the sun's pole. Thereby it may be judged whether the constituents of the sun's surroundings vary with their solar latitude.



Mr. Evershed's Observing Hut at Mazafram, showing the Cœlostat.
Photographed by E. WALTER MAUNDER.

In addition he used two large prisms in conjunction with a large reflector. It is already a matter of history how that Mr. Evershed found himself, when the shadow passed, about one hundred yards outside it, and not as he had hoped two miles within. Though actually outside the total phase, he got some photographs of the "Flash" of most exceptional beauty; but probably not one-fourth of the result which he would have got had he had more accurate values for the position of the shadow track.

In another way his experience is of very great value, though not by any means in the manner he intended or desired. The farmers and sightseers in his near neighbourhood had a vehement discussion as to whether the eclipse was total or not. They divided themselves into two parties, those who saw the sun completely disappear, and those who described the corona as creeping round to the moon up to a point where there was a small remnant of sunlight. It got as far as this point but no further, and straightway began to creep back again and vanish. These latter also spoke of the sharp dividing line of light and shadow which sped across the Mediterranean to their left hand. The division was, or appeared to them to be, bordered by a bright line. Investigation proved that both the parties were in the right, for they had been separated by some five hundred yards, the line of total phase passing between the inner party and Mr. Evershed's tent. This unique observation affords a most accurate datum to correct the computation of solar eclipses in the future. It is a pity, however, that such an observation should have been at the expense of Mr. Evershed's special researches.

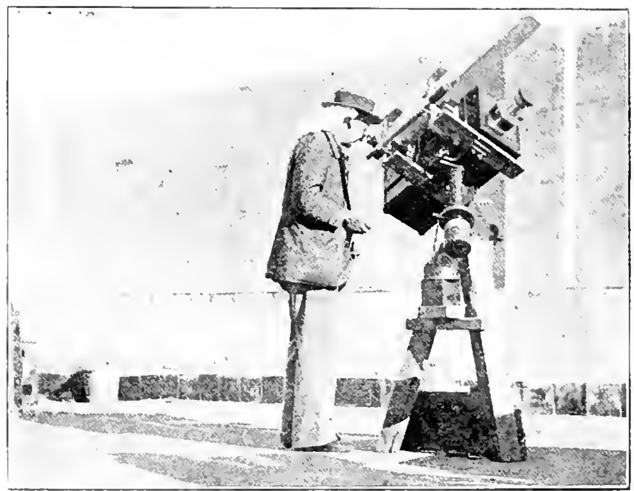
Besides Mr. Evershed at Mazafram, Mr. Newall, Prof. Turner and Mr. Wesley at Bou Zaréa, and a strong party of Swiss and Italian astronomers at Ménerville, more than twenty members of the British Astronomical Association took up their quarters in the city of Algiers itself, and observed with us from the roof of the Hotel de la Régence.

Our own particular work was photographic. It may be remembered that our programme in India was to take *in duplicate* a series of graduated exposures varying in equivalent efficiency from 1 to 1800. Our hope had been that the longer of these exposures might secure the faint coronal extensions, but our purpose was in any case to learn more than had yet been done as to the real efficiency of different exposures in coronal photography. It was the first time, it was the only time, that such an attempt had been made except within quite narrow limits.

It is well known that we were doubly fortunate. Our series included six different exposures equivalent to 1, $4\frac{1}{2}$, 20, 90, 400, 1800, each exposure being given in duplicate so that twelve plates were exposed in all. From the twelve plates we secured four photographs successful as such, but each plate had its full value as a lesson in exposures, and three recorded the long rays.

Seeing that our longest exposures were the most successful in bringing up the long rays, the question before us this time was, Had we reached the limit in India of successful exposure, or had we not? If not, how far could we extend it?

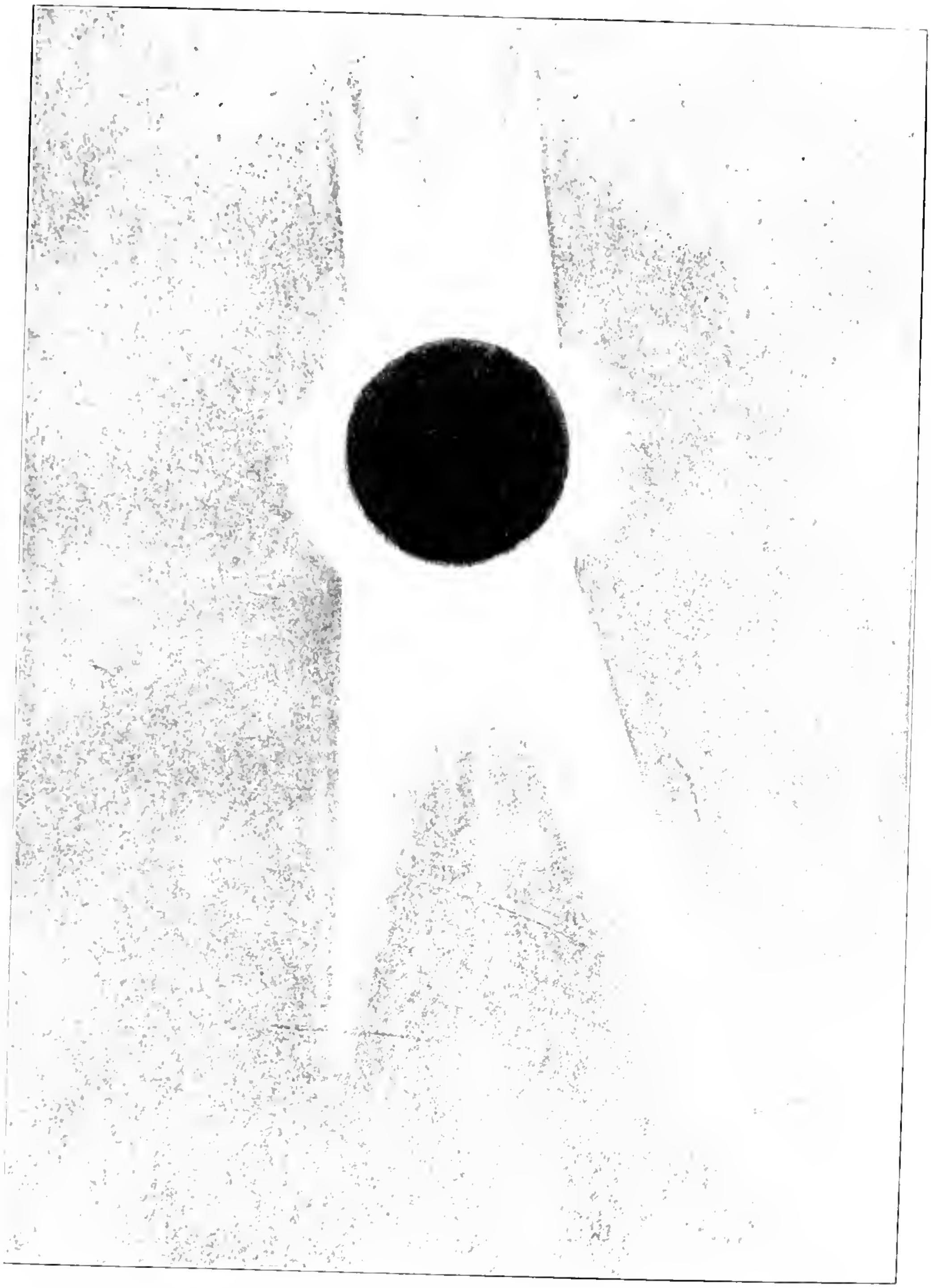
Here we met a serious difficulty, for totality at Algiers would last barely 62 seconds, and we could not



On the Roof of the Hotel de la Régence, Algiers. Rev. C. D. P. Davies and Telephotographic Camera.
Photographed by MISS EDITH MAUNDER.

expose for the entire time. It was moreover our principle to trust nothing to a single plate; we resolved to adhere strictly to our Indian precedent in this respect and make every exposure in duplicate.

We got over the difficulty in this way. We purchased a second Dallmeyer stigmatic lens of the same aperture and focal length as that used in 1898, and we exposed a plate with each for 48 seconds instead of 20 seconds in India. This was to increase the exposure in the ratio of 12 to 5. We were anxious, however, not to confine ourselves to a pair of exposures of one length only, and consequently purchased a pair of R.R. lenses of focal length double that of the stigmatic, and which we used at the same aperture as we had done the former, namely, $1\frac{1}{2}$ inches. The effective exposure therefore for these lenses—which we also exposed for 48 seconds—was but one-quarter that of the stigmatic or three-fifths the longest exposure



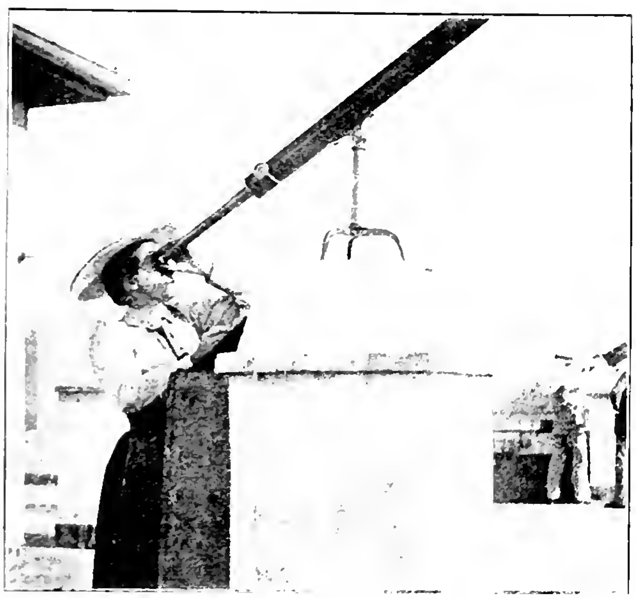
THE CORONA OF 1900, MAY 28.

From a Drawing by Miss Catherine O. Stevens, at the Hotel de la Régence, Algiers.

given in India. We hoped that the two pairs of exposures would therefore enable us to judge whether our Indian exposures were the best possible, or whether they were too long, or whether, on the other hand, they might be safely increased. For the rest we had no wish to exactly repeat our Indian experiment, as we knew that this was being done by many competent photographers with a variety of lenses and at several widely separated stations.

The result of our photographs show clearly that for this eclipse at any rate the exposures which we have given are too long; at least for the purpose of securing the extensions. Totality lasting but for 62 seconds, an exposure from the sixth second to the fifty-fourth meant that the chromosphere was uncovered both at the beginning and end of totality, and that the brightest layers of the corona were practically exerting their influence the whole time. The consequence was that the sky illumination was far greater than at mid-totality in the Indian eclipse, and probably on this account the extensions cannot be traced to so great a distance. We can feel no regret that this is the case. It was our deliberate choice to extend the exposure as much as the circumstances of the eclipse allowed that we might complete our Indian experiences as fully as possible. We trust, however, and have reason to hope that at some of the other stations—possibly at several—those photographers who were trying for the extensions will prove to have secured them to a much greater extent than we have on the present occasion. Nevertheless, our photographs seem sufficient to show that those rod-like rays stretch out from the synclinal curves of the corona of 1900 as they did from that of 1898.

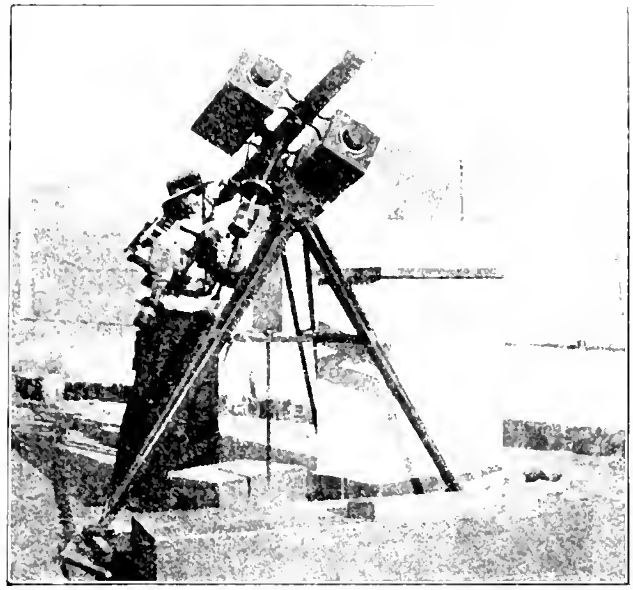
The present article is already sufficiently long, and we



On the Roof of the Hotel de la Régence, Algiers. Miss Leake at her Telescope.
Photographed by Miss Edith Maunder.

must postpone to another month the consideration of many important observations. Amongst these we would specially mention studies at the telescope of the details of coronal structure. These were carried out most successfully on the present occasion by Mr. Wesley, Mr. Crommelin, Miss Leake, and no doubt many others, and form quite a new chapter in coronal observation. The observations of the shadow bands were also of unusual interest, and no doubt the next week or two will bring us much further information as to the details of coronal structure shown on the numerous short exposure photographs.

We reproduce a beautiful drawing made at our



On the Roof of the Hotel de la Régence, Algiers. Mrs. Walter Maunder and her Two Cameras.
Photographed by Miss Edith Maunder.

Algiers station by Miss C. O. Stevens. It will be seen that the form of the corona reproduced with astonishing fidelity that seen in the eclipses of 1878 and 1889, respectively two and one complete sunspot cycles earlier.

THE GREAT INDIAN EARTHQUAKE OF 1897.

By Charles Davison, sc.d., f.g.s.

To the inhabitants of India, the year 1897 will long rank as a year of great calamities. A famine in Bengal and the plague in Bombay were followed on June 12 by an earthquake in Assam, which, if it is not without a rival, is certainly one of the most disastrous and widely felt of which we possess any record. The investigation of the earthquake was at once undertaken by the members of the Geological Survey of India. The four officers who were at the headquarters in Calcutta were despatched to collect information from the area in which the chief damage was done, letters and circulars were distributed as widely as possible, a large number of volunteer observers were induced to co-operate by keeping records of the after-shocks, and, later on, during the cold weather of 1897-1898, Mr. R. D. Oldham, one of the superintendents of the Survey, made a tour through the epicentral district. To Mr. Oldham has also fallen the much more severe task of collating the observations, of determining the value to be assigned to each, and of discovering the conclusions to which they lead. The latest volume of the *Memoirs* of the Geological Survey of India, a book of more than 400 pages, contains the fruit of his work; the interest and importance of which will be seen from the summary given in the following pages.

Disturbed Area, etc.

The area over which the earthquake was perceptible is shown in Fig. 1. It will be seen that its boundary (indicated by a dotted line) can only be traced for part of its course; for one-third of the area, Mr. Oldham estimates, lay in regions from which information was unobtainable, while another third is sparsely inhabited by ignorant and illiterate tribes. But, notwithstanding this, the shock is known to have been felt over an area of at least 1,200,000 square miles. If we include the detached region to the west, near Ahmedabad, the portion of the Bay of Bengal in which the shock would have been perceptible if the sea had been replaced by land, and a large part of Thibet or Western China, from which no reports have come but in which the shock was certainly sensible, this estimate, great as it is, must be raised to about 1,750,000 square miles.

It does not appear that any other earthquake, of which we possess reliable records, has been felt over so wide a region. Until 1897, the great Lisbon earthquake of 1755 had no competitor in this respect; but of its disturbed area we have no exact knowledge, for the focus was situated beneath the Atlantic Ocean. There are some doubtful records of the shock having been actually felt at Reading and in Derbyshire, and also at Milan and Turin. If we exclude these, Mr. Oldham estimates the total area over which the Lisbon earthquake would have been felt, had it all been dry land, as not more than a million square miles.

Of the other two curves on the map in Fig. 1, the continuous line represents the epicentral area, and the broken line bounds the district in which serious damage was done to masonry. The area of the latter is not less than 145,000 square miles, or 160,000 square miles, if we include the part from which records were not obtainable.* Calcutta lies within the area of destruction, and a good deal of damage was done to buildings in the city; but this, as Mr. Oldham points out, was largely due to their peculiar mode of construction.

Figures, such as those quoted above, give but little idea of the vastness of the areas concerned. Transferring them to countries with which we are better acquainted, we may say that the disturbed area was only a little less than half the size of Europe; the region in which serious damage occurred to masonry was more than twice as large as the whole of Great Britain; while, if the centre of the epicentral tract had been in Birmingham, nearly every brick and stone building in England and Wales from York to Exeter would have been levelled to the ground.

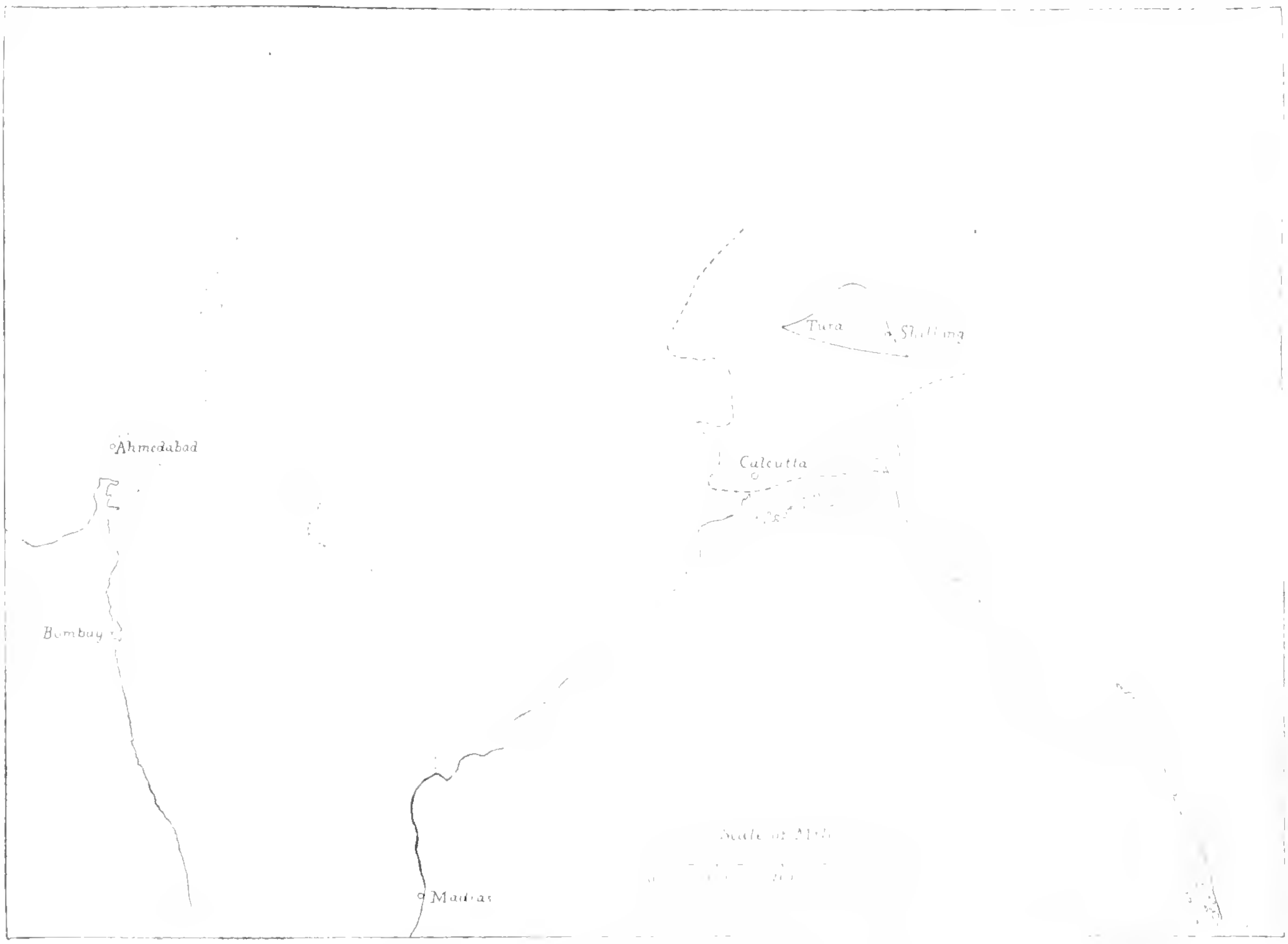


FIG. 1.—Map of the Disturbed Area of the Indian Earthquake of 1897.

* Mr. Oldham does not refer to the corresponding area for the Lisbon earthquake. I am not prepared to make even a rough estimate of its extent; but, if the reports of damage in Spanish towns (without speaking of those in Morocco) are correct, it must, I think, have been in excess of the higher of the above figures.

Nature of the Shock.

"I was out for a walk at the time," says Mr. F. H. Smith, of the Geological Survey of India, "and was standing on the road which passes the foot of the filtering tank of the Shillong waterworks, near the school. At 5.15 (according to the ordinary Shillong time) a deep rumbling sound, like near thunder, commenced. The rumbling preceded the shock by about two seconds, and the shock reached its maximum violence almost at once. The ground began to rock violently, and in a few seconds it was impossible to stand upright, and I had to sit down suddenly on the road. The shock was of considerable duration, and maintained roughly the same amount of violence from the beginning to the end. It produced a very distinct sensation of sea-sickness. The earth-movement was exceedingly sudden and violent. The feeling was as if the ground was being violently jerked backwards and forwards very rapidly, every third or fourth jerk being of greater scope than the intermediate ones. The surface of the ground vibrated visibly in every direction, as if it was made of soft jelly; and long cracks appeared at once along the road. The sloping earth-bank round the water tank, which was some 10 feet high, began to shake down, and at one point cracked and opened out bodily. The road is bounded here and there by low banks of earth, about 2 feet high, and these were all shaken down quite flat. The school building, which was in sight, began to shake at the first shock, and large slabs of plaster fell from the walls at once. A few moments afterwards the whole building was lying flat, the walls collapsed, and the corrugated iron roof lying bent and broken on the ground. A pink cloud of plaster and dust was seen hanging over every house in Shillong at the end of the shock." †

Many other observers within and near the epicentral district noticed a marked undulation of the ground. According to one at Shillong, the surface of the earth presented "the aspect of a storm-tossed sea, with this difference that the undulations were infinitely more rapid than any seen at sea." Mr. Oldham thinks that, on an average, the waves were about 30 feet long and one foot in height, though some may have been both shorter and higher. They could be seen following each other at intervals, and the rate at which they travelled, as one witness states, "though decidedly faster than a man could walk, was not so fast as he could run."

In the epicentral area there was a considerable vertical component in the motion, for loose stones on the roads were tossed in the air "like peas on a drum." At the same time there was a still more marked horizontal movement, the range of which must have been at least 8 or 9 inches, and during which people felt as if they were being shaken like a rat by a terrier. As they left the epicentral region, the waves lengthened out, so that, at a distance, the shock no longer consisted of short jerks but became a gentle rocking motion, occasionally giving rise to a sensation of nausea.

Sound-Phenomena.

According to an observer at Shillong, the crash of houses falling within thirty yards was completely drowned by the roar of the earthquake. The sounds are generally described as resembling distant thunder, the passage of a train or cart, etc. There was the usual conflict in the evidence of different observers due to the depth of the sound ‡. In Calcutta, which lies well within the sound-area, some persons asserted that they heard a rumbling noise; others were positive that the only noise was that caused by falling buildings and furniture. Some, again, noticed that the shock was preceded by a loud roar; while others were certain that there was no sound of any kind until the earthquake had become severe.

Leaving possibly doubtful records out of account, the sound was heard for a distance of 330 miles to the west and south-west, and 290 miles to the east of the epicentral area; that is, allowing for the dimensions of that area, it must have been perceptible over a district measuring not less than 800 miles from east to west.

Besides these sounds, several observers in different parts of the disturbed area heard after the shock was over three or more loud and short explosive sounds, like the booms of cannons fired a few miles away. Though, as Mr. Oldham remarks, the sounds were evidently connected with the earthquake, they were separated from it by an interval too great for them to be due to the passage of the sound-wave through the air.

After-Shocks.

However scanty the preparation for it may have been, a great earthquake is always followed by an attendant crowd of after-shocks, which, for months or even years, do not altogether cease. Near the centre, they are so numerous as to baffle all inquiry. For several days, it may be, the ground is hardly ever still. At Tura, in the epicentral area of the Indian earthquake, several hundred shocks were at first felt every day, and for three or four days a hanging lamp was kept constantly on the swing; while, at another place within the same area, the surface of a glass of water standing on a table was for a week in a constant state of tremor. On June 13, the day after the great earthquake, there were two shocks which would certainly have caused considerable destruction in the central area if any houses had been left standing; while a third shock, later in the day, was felt as far as Calcutta.

Velocity of the Earth-Waves.

Among the minor problems which a great earthquake presents for solution, one of the most important is to determine the velocity with which the earth-waves were propagated along the surface. The best determinations of the time are those which were obtained from a few self-recording instruments, from the more busy telegraph-offices, from the larger railway stations, and especially from those on the main lines, and in some cases from private individuals. The average of the observations at Calcutta (including that from the tide-gauge) gives 16h. 27m. 49s. (Madras time, which is 5h. 20m. 59.2s. in advance of Greenwich time) for the beginning of the shock. Bombay lies outside the disturbed area, but the initial time there, as determined from the diagrams of three magnetographs and a barograph, is 16h. 35¼m. These two records are probably the most accurate of the series. In calculating the surface-velocity of the earth-waves, Mr. Oldham assumes that they started from a point in lat. 25° 45′ N. and long. 90° 15′ E. From this point, Calcutta is 255.5 miles distant, and Bombay 1208.3 miles. The average velocity for the intervening distance is therefore 119 miles a minute or 3 km. a

† I have abridged this account slightly, without indicating the passages that are omitted.

‡ See Knowledge, Vol. XXIII., 1900, pp. 83–85.

second. With this estimate, the other observations are in fairly close agreement.

THE UNFELT EARTHQUAKE.

Far beyond the limits of the disturbed area, the earthquake was recorded by many of the delicate instruments constructed for the registration of distant shocks.§ All over Italy, from Ischia and Catania in the south to Pavia in the north, these instruments began, one after the other, to write their records of the movement, as the unfelt earth-waves sped outwards from the centre. Italy passed, the tale was taken up by magnetographs at Potsdam and Wilhelmshaven, Pawlovsk (near St. Petersburg), Copenhagen, Utrecht, and Parc St. Maur (near Paris); by horizontal pendulums at Strassburg and Shide (in the Isle of Wight), and by a bifilar pendulum at Edinburgh. Shide is 4891 miles from the centre of disturbance, but the movement could be traced for a distance greater even than this.

In the more complete records, and especially in those given by the Italian microseismographs, Mr. Oldham distinguishes three phases of motion. The first consists of nearly horizontal rapid displacements of the instruments without any undulating movement of the ground. In Italy, it begins at about 11.17 a.m. (G.M.T.), that is, about 12½ minutes after the commencement of the shock at the epicentre. Without any break in the movement, and after the lapse of about 8½ minutes, the second phase begins; the vibrations are similar to the preceding, but they are larger and more open, and are accompanied by an unmistakable tilting of the surface of the ground. Lastly, after the lapse of nearly 20 minutes more, the second phase gives place, without interruption, to the third, consisting of well-marked slow undulations, which have been aptly compared to the movements caused by an ocean-swell. As they travelled over Europe, the surface of the ground was thrown into a series of flat waves, 34 miles in length, and 20 inches in maximum height, the complete period of each wave being 22 seconds. This phase is by far the longest of the three; in the more sensitive instruments, two or three hours elapsed before their traces ceased to show signs of movement.

As we know the distances of the different observatories from the epicentre, and the times taken by each phase to reach them, we can form some idea of the rates at which they travelled. If the early tremors moved in straight lines, their mean velocity for the first phase was 9.0 kilometres per second or about 345 miles a minute, and for the second 5.3 kilometres per second or about 200 miles per minute. But if, as is probable, they moved along curved paths through the body of the earth, their mean velocities must have exceeded these amounts. For the first undulations of the third phase, the velocity would be 2.9 kilometres per second or 109 miles per minute if they travelled along straight lines, or 3.0 kilometres per second or 115 miles per minute if they moved along the surface of the earth.

The existence of the second phase was noticed for the first time by Mr. Oldham in the records of the Indian earthquake, but he has since detected it in those of other shocks.‖ He believes, in common with most other seismologists, that the first phase corresponds to waves of elastic compression travelling through the body of the earth; and he attributes the second to waves of elastic distortion travelling in the same way, in which the particles move at right angles to the direction in which the wave travels, thus causing a slight tilting of the surface. It is probable that the waves of both phases move along curved, rather than straight, lines through the earth, that the curves are concave towards the surface, and that the velocities of the waves increase with the depth of their path below the surface. On the other hand, the surface-velocity of the first undulations of the third phase is practically constant for all distances from the epicentre, and, in the case of the Indian earthquake, it agrees almost exactly with that obtained for the velocity within the disturbed area and as far as Bombay. It is therefore difficult to resist the conclusion that the third phase consists of undulations which travel along the surface of the earth.

If this be the case, we can imagine these undulations speeding outwards from the epicentre in ever-widening circles, until they have passed over a quarter-circumference of the earth, when they should begin to converge towards the antipodes. Here they should cross each other, and again spread out as circular waves, once more in their course passing the same observatories where they were first recorded, but in the opposite order. It has been reserved for the most violent earthquake of modern times to verify this interesting conclusion. Faint, but decided, are the traces of the second crossing. At Edinburgh they occur at 2.6 p.m., and at about the same time at Shide, at Leghorn 2.10, Catania 2.12¾, while at Ischia there are several movements between 2 and 3 p.m. At Rocca di Papa, near Rome, the time is slightly earlier, but the undulations, like those at the first crossing, have a complete period of about 20 seconds. The distances traversed by the waves are more than 20,000, instead of less than 5000, miles; but the mean velocity of travel is almost exactly the same as at first—namely, 2.95 kilometres per second, or 111 miles per minute.

(*To be concluded.*)

§ For descriptions of the more important see *Brit. Assoc. Rep.*, 1893, pp. 291–303; 1895, pp. 85–86; 1896, pp. 40–49; 1897, pp. 10–11. *Nature*, Vol. L., 1894, pp. 246–249. *Natural Science*, Vol. VIII., 1896, pp. 233–238.

‖ *Phil. Trans.*, 1900, A., pp. 135–174.

AMERICAN INDIANS.

By R. LYDEKKER.

ALTHOUGH now used in a totally different sense, the title of Americans undoubtedly belongs by right of birth to the aboriginal tribes who were in possession of the New World previous to the incursion of the white man and their modern pure-bred descendants. But to change this usage is now clearly impossible, and some other general title must consequently be sought. By a curious misapplication of terms the American aborigines are almost invariably spoken of as "Indians," while the natives of Hindustan, to whom that name by right belongs, are scarcely ever so called, except indeed by those well-meaning enthusiasts who seek to claim "India for the Indians." Still it is, on the whole, the wisest course to bow to custom and accept the current name of American Indians; the alternative designation of American Aborigines, or the Aborigines of America, being too cumbersome for ordinary use.

There is, it is true, the popular title of "Redskins"; but this, however expressive it may be, is somewhat too "slangy" for present purposes. Moreover, it has been objected to as inappropriate—but of this more anon.

If we except the Eskimo of Arctic America and Greenland, and in a less degree the natives of Tierra del Fuego, the most remarkable fact connected with American Indians, when considered from a zoological standpoint, is that they all belong to the same general type of structure, still in minor details many of the tribes from widely separated areas will be found to differ from one another to a considerable extent. No more striking instance of this fact is to be found than the extraordinary similarity existing between skulls obtained from regions so far apart from one another as Vancouver Island, Peru, and Patagonia—a similarity so great that it is often practically impossible to distinguish between them.

In spite of this adherence to one general physical type, the racial unity of the American Indians has been called in question by several writers; and it has even been suggested that many of the tribes, and especially those of South America, owe their peculiarities to immigration from Japan, China, Polynesia, or elsewhere. But it may be taken for granted that no immigration on a large scale could ever have taken place by sea from either of these areas to America; and if one, or even two or three junks or canoes were from time to time drifted to the shores of the New World it is quite certain that any modifications in the coast population of the latter due to marriage with the shipwrecked crews would be obliterated within a very short period.

We may take it, then, as a fact that the pure-bred American Indians (and it is these alone that concern us), from Canada in the north to Patagonia and Tierra del Fuego in the south, form but a single race. And the question then arises whether the ancestors of that race obtained an entrance into America from the Old World, or whether they were American from the beginning. To that question—provided we are believers in evolution—the answer is very short and simple. On the evolutionary hypothesis man must be descended from the ancestors of the manlike Apes—whether his origin be single or multiple need not concern us here; and since the manlike Apes, both now and in the past, are quite unknown in the New World, it is manifest that the original American Indian must have been an immigrant from the Old World. That such an immigration must have taken place at a very remote epoch is proved by abundant evidence; but the available data are at present quite insufficient for forming even an approximate estimate of the length of time that has elapsed since that distant epoch. With regard to the route by which man reached the New World, the probability that an isthmus formerly occupied the present area of Bering Strait suggests that line of migration. And this view receives a considerable amount of support from the fact that the nearest relatives of the American Indians are the Mongols of north-eastern Asia. Still it has to be admitted that climatic conditions present a certain amount of difficulty in our definite acceptation of that line of route as the one by which the progenitors of the American aborigines reached their western home. Moreover, from the fact that skulls of both an elongated and a short type have been discovered in certain superficial deposits of Argentina and Brazil, some writers have been led to conclude that a double emigration took place into America—namely, a migration of round-headed Mongols from Asia by way of Bering Strait, and another, and perhaps earlier, incursion of long-headed people from Europe by way of Greenland. But if we are right regarding the native Americans as a branch of the Mongol stock, it is difficult to see how they can at the same time be considered to include a large admixture of primitive Caucasian blood; and it must be borne in mind that the Eskimo, who can scarcely be regarded otherwise than modified Mongols, are essentially a long-headed people.

By whatever route, or routes, he reached the Western hemisphere, man having arrived there became at once (or, in the case of two migrations, eventually) entirely separated from his relatives in the Old World. Having been thus isolated during the long ages which elapsed between the period of the original migration (or migrations) and the white colonization of the New World after its reputed discovery by Columbus, the wonder is not that the aboriginal American differs so decidedly from the Mongol, but rather that there are so many points of resemblance still remaining between the two. And here it is important to mention that, in all probability, it is not the American Indian alone whose type has become modified in the course of ages, but that the Mongol has also undergone a certain amount of change since the date when the western and eastern branches of the common ancestral stock parted company for ever.

There are four chief features in which the American Indians conform to the Mongol type—namely, in colour, in the characters of the hair of the scalp, in the very slight development of hair on the face, and in the more or less marked prominence of the cheek-bones. As regards colour, it is well known that all Mongols have a

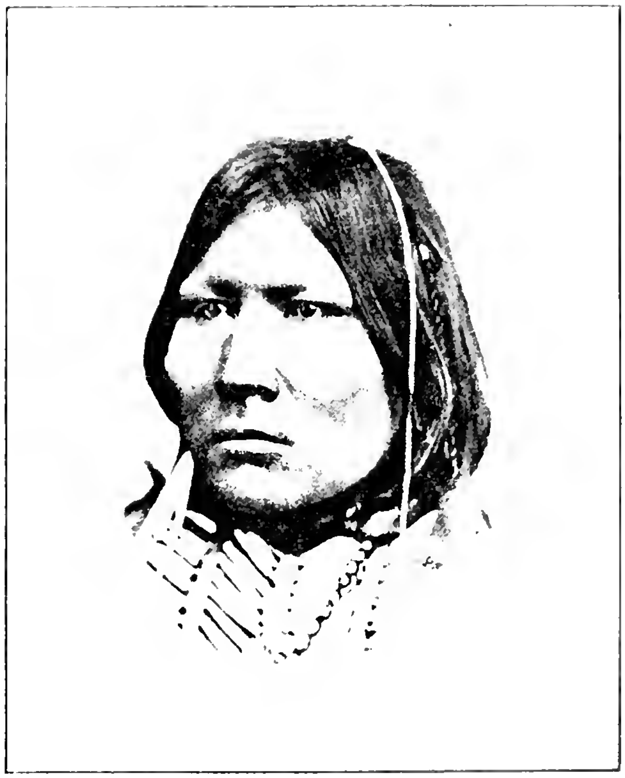


Fig. 1.—A Typical North American Indian.

yellow skin, and this yellow tinge is frequently retained in their American cousins, although in many instances it is replaced by coppery red. It is true that this red tint is stated by some writers* to be solely due to paint-

* *See* Deniker, "The Races of Man," page 517. (1900.)

ing, and that the American Indian is invariably yellow. But Mr. Im Thurn, who has had special opportunities of observing them, describes the skin of the Indians of British Guiana as cinnamon red; and a bust of a Macusi boy, now in the British Museum, which was modelled and coloured by Mrs. Im Thurn, is of a bright clarety-red. As these Macusi Indians are noted for their frequent ablutions, it is evident that they exhibit the natural hue of the skin; and it may accordingly be taken as a fact that a reddish skin is characteristic of at least some of the aboriginal tribes of America.

Although there are stated to be certain South American tribes in which it displays a tendency to waviness, the scalp-hair of the typical American Indian is of the long, coarse, straight, black type which forms such a characteristic feature of the Chinaman. Hair of this type presents a perfectly circular cross-section, and therefore has no tendency to twist, but hangs as straight down as that of a horse's mane or tail. It is to be met with from Canada to Patagonia, all North American Indians exhibiting this type in perfection (Fig. 1); while it is equally apparent in those curious mummified and shrunken heads from Ecuador which command such high prices at "curio" sales. In the above instances the hair is allowed to grow long, when its characteristic features are best displayed; but in many tribes of South America, such as the Tupis of Brazil (Fig. 2), it is cut short, when a more European appearance is given to the entire countenance. In both the figures just referred to, the absence of hair on the face, which forms such a marked characteristic of both Mongols and American Indians, is very conspicuous; but it should be added that, like Chinamen, the majority of the native tribes of America are in the habit of plucking out the comparatively few hairs that make their appearance on the face. As regards the cheek-bones, these are always decidedly more prominent than in Europeans, although less projecting than in Chinese. Generally speaking, the degree of prominence is considerably more marked in the tribes of North America than in those further to the south, as may be seen by comparing Fig. 1 with Fig. 2; and, indeed, this is just what might be expected to occur on the hypothesis that the American aborigines came by land from Asia, since the further south they wandered the more widely they would tend to depart in physical features from the Mongolian prototype. But in spite of this and other differences to be noticed immediately, the retention of the Mongoloid type even among the natives of South America is very noticeable; Sir William Flower remarking that no one can have seen a group of Botocudos from Brazil or of natives of Tierra del Fuego without being struck by their markedly Mongolian external features.

Turning to the points in which American Indians differ from their Mongolian cousins, the most important are to be found in the retreating slope of the forehead, the development of distinct brow-ridges above the eyes, the general absence of obliquity in the eyes themselves, and the much more prominent nose, which is usually narrow, with a high bridge, and frequently an aquiline profile, in which two lines meet at an obtuse angle at the bridge. All these points of difference tend to more or less completely obliterate the breadth and flatness of face so characteristic of the oblique-eyed Mongol. But here and there cases are recorded where, instead of the small, sunken, and circular coal-black eye, the eyelids assume the typical Mongolian folding and obliquity, and thus communicate a strikingly Chinese expression to the entire countenance. In this connection it has to be borne in mind that the Malays, who are comparatively near relatives of the Chinese, have more or less completely lost the oblique and slit-like "Mongol eye," so that the disappearance of the same feature in the American tribes should be no cause for wonderment. It might, of course, be urged that the "Mongol eye" was acquired in Asia subsequently to the splitting-off of the American branch, but the fact that the feature

Fig. 2.—Male Indians of the Turi-nara Tribe of the Tupi Stock, from the Rio Neara, Para, Brazil.
Photographed by Dr. E. Goeldi.

in question occurs to a certain extent among the Eskimo, an ancient Mongolian offshoot whose relationship to the American Indians is not yet decided, seems to be decidedly against such an hypothesis.

Another point in which the American Indian differs from his Mongolian prototype is his superior bodily stature; an average height of 5 feet 8 or 9 inches being common over the greater part of the continent, while in Patagonia it rises to as much as six feet. Here, again, we have another instance of the extreme degree of divergence from the Mongolian type occurring in the part of the New World the most remote from Bering Strait. In the Fuegians it is true that the height falls so low as five feet, but this inferiority of stature is obviously due to the hard conditions under which these degraded people exist. Compared with the squat and flat-faced Tatar or Chinaman, the American Indian, in the higher phases of his development, makes indeed a far nearer approximation to the ideal standard of physical beauty, although his features are frequently by no means of a pleasing type, and the practice so common in the northern half of the continent of wearing the hair long, coupled with the absence of beard and moustache, gives the men a somewhat feminine appearance.

Bearing in mind what has been said in regard to the universal prevalence of a long-headed type among the Eskimo, the fact that while the Mongols are a short-headed people, a large proportion of the American aborigines have heads of medium length, can scarcely be regarded as a distinctive feature of first-class importance.

It is, moreover, noteworthy that the Indians of North America may be divided into an eastern, or Atlantic, and a western, or Pacific, section the former of which is characterised by its tall stature and moderately long head, while the latter is of inferior bodily height and shorter-headed In this instance also we see the section nearest to Bering Strait retaining the Mongoloid characters, although it should be added that they are somewhat more hairy than the eastern section. For the rest, it must suffice to say that both long, medium, and rather short-headed tribes are met with in South America; the former showing a tendency to wavy hair. The tribes in which the head is longest are the Botocudos of

Fig. 3.—Young Females, Turi-nara Indians.
From a Photograph by Dr. E. Goeldi.

Brazil, next to whom come the Fuegians, while the approximation to a round-headed type is most marked among the Patagonians.

Apart from the Eskimo, the aborigines of the New World may be conveniently divided into North, Central, and South Americans, and Patagonians. As already mentioned, the North Americans may be divided into a western and an eastern section, the latter being further subdivisible into an Atlantic and an Arctic group. To give the names of the numerous tribes constituting these sections and groups would but weary the reader to no purpose, and would likewise be well nigh impossible within the limits of my space. Allusion may, however, be made to some of the chief linguistic families, or stocks, into which the tribes may be grouped—language being almost the only practical means of classifying American Indians. Foremost among the families of the Arctic slope are the Athabascans: some tribes of which—the Navajos and the Apaches—have, however, migrated south into Arizona and New Mexico On the Atlantic slope the Algonquians even exceed the Athabascans in numbers, and are the largest living family; some of their best known tribes are the Crees, the Mohicans, and the Chippewas. Among the other Atlantic stocks are the Iroquoians (as represented by the Iroquois and the Mohawks), the Muskhogeans (including the Choctaws, and Creeks or Muskhogis), and the Siouans, some of the most famous tribes of the latter being the Sioux or Dakotas, and the Crows. The Pawnee and Kiowa tribes seem to fall into neither of the great linguistic divisions. Turning to the Indians of the Pacific slope, whose tendency to a round-headed character has been already mentioned, these appear to form but a single linguistic stock. Their most interesting representatives are, however, the so-called Pueblo (Village) Indians of the plateau of Arizona, New Mexico, and parts of the adjacent territories, who have forsaken the nomad habits of their fellow aborigines to dwell in large caves hollowed out of the steep banks of cañons, or in large villages (pueblos) built by themselves. These Mokis and Hopis, as they term themselves, are the tallest and most round-headed of all the North American tribes, and possess a number of very remarkable cults and ceremonies, among which the snake-dance is perhaps the most widely celebrated

Mexico is largely populated by the Sonoran and the celebrated Aztec group; the former being allied by blood to the North Americans of the Atlantic slope, while the latter are more nearly akin to the tribes of Central America. In their mode of life and customs both approximate to the Pueblo Indians; the Pina and Papajo tribes of the Sonorans, for instance, dwelling in large many-storied dwellings commonly known as *casas grandes*, and cultivating with perseverance the sterile soil of the Gila valley—the home, by the way, of that poisonous lizard which is hence known as the Gila monster (*Heloderma suspectum*). The Aztecs, who populated the Pacific slope at the same time that the Atlantic sea-board was occupied by their relatives the Nahuas, are known to fame by reason of the comparatively civilized empire they had succeeded in establishing a few centuries previous to the devastating advent of the Spanish *conquistadores*. Among the inhabitants of Central America, which also extend into southern Mexico, the most celebrated are the ancient Mayas of the Mayo valley, Yucatan, whose civilization was akin to that of Mexico, while their writing ("the Maya script") forms an anologue to the hieroglyphics of ancient Egypt. Another well-known Mexican tribe are the Miztecs.

Between Guatemala and Panama dwell a certain number of tribes speaking dialects differing from any of the American stock languages; the most noteworthy among them being the Mosco, or Mosquito Indians, who are nearly as black as Negroes, but otherwise conforming to the general American type.

Very brief must be the mention of the South American aborigines, among which are included all those dwelling to the south of the northern frontier of Costa Rica. Among the Andean section the most interesting linguistic stock is that of the Quechua, on account of its including the ancient Incas of Peru. In western South America, Quechua was, indeed, the *lingua franca*, as it is to a considerable extent at the present day; while the Quechua words *condor*, *guano*, *pampa*, and *quina* have been adopted in European languages. While speaking a different tongue, the Araucans, of Chili and part of Argentina, conform physically to the Quechua, and their relatives the Aymaras. In the Amazonian section come the Caribeans, ethnologically distinguished by their use of the hammock, and including a host of tribes, among whom are the true Caribs of the Antilles and many districts of the mainland, and the Makusis of British Guiana; a peculiar feature of the latter being their habit of going about with down-cast eyes. Another linguistic stock in this section is that of the

Arawaks. The Indians of East Brazil and Central South America form a third section; among whom the Tupi-Guarani linguistic stock, whose language forms the *lingua franca* of the eastern side of the continent, is the most important. To this stock belongs the tribe from Para, of which representatives are shown in Figs. 2 and 3. Lastly, we have the Pampean and Fuegian section. Of the mainland tribes of this section the more notable are the Tehuelches, or Patagonians, who inhabit the country lying between the Rio Negro and the Magellan Strait, and are the tallest of the American aborigines, although somewhat exaggerated notions have been entertained in regard to their height. As to the Fuegians, who are restricted to the southern and western coasts of the bleak island from which they take their name, space only permits of the statement that they are, on the whole, the most degraded and the most wretched of all the American Indians.

SOME EARLY THEORIES ON FERMENTATION.—I.

By W. Stanley Smith, ph.d.

In the year of grace, 1636, Thomas Hobbes, the famous author of "Leviathan," wrote a letter from Paris to the Duke of Newcastle. There are some sentiments in this letter so expressive of the attitudes adopted by the leading natural philosophers of each age, that we may well use them as a prelude to our short survey of the theories that have successively surrounded the fermentation of sugars and other materials. "In thinges," says Hobbes, "that are not demonstrable, of which kind is the greatest part of naturall philosophy, as dependinge upon the motion of bodies so subtile as they are invisible, such as are ayre and spirits, the most that can be atteyned unto is to have such opinions as no certayne experience can confute, and from which can be deduced, by lawfull argumentation, no absurdity." It has been said that the essence of our modern superiority to the earlier philosopher consists in our having accumulated more facts, but a moment's thought will teach us, if, indeed, the lives and works of men like Huxley and Pasteur do not teach us, that our greatest strength lies not so much in mere knowledge of facts, but rather in the acquisition of rightful methods of research, and the clearing of pathways that lead to Nature's most umbrageous nooks and crannies.

Records of fermented juices, both of cereals and fruits, extend as far as historical research can penetrate. Every mention of the results of fermentative changes preceding the era of Christendom is distinguished by the fact that supernatural powers are credited with the functions we now attribute to living realities of daily life, so that Osiris and Bacchus are held responsible for the early wine and beer, and we may deem their adorers justified in their worship, for they had "no certayne experience" to refute the notions they held as to these deities and their functions. The first name of any note is that of the famous naturalist, Pliny, in whose observation of the presence of an acid in the fermentation of bread we discern the primitive glimmerings of investigation in these dark regions; and he possesses a further interest for us, inasmuch as Pliny was probably one of the first martyrs in the cause of knowledge. He died, at the age of fifty-six, whilst attempting to ascend Vesuvius during the historic eruption which laid Pompeii and Herculaneum in dust and ashes. Plutarch, who was born in the year 48, in his works presents us with many curious and trite observations on the learning and customs of those times, and we mention, as especially interesting to our subject, his remarks on the benefit of warmth, and retarding influence of cold, on the progress of fermentation.

It is to Djafer al Geber that we owe the discovery of the art of distillation, besides which he appears to have been the first alchemist to perform the operations of filtering, evaporating, crystallising, and dissolving metals in acids. Geber describes his processes in the mystic phraseology of those times, and does not fail to mention the "elevation of dry substances by fire," now known as the act of sublimation. Rhazes, a Baghdad physician, who flourished between the years 860—940, was the first to give accurate directions for the production of aqua vitæ by distillation, and means by which a still more concentrated spirit may be obtained therefrom—namely, by another distillation over quicklime.

The words fermentatio and digestio appear to have been used by the early alchemists to indicate the same process, namely, a frothing or evolution of gas accompanying a chemical reaction. The substance or reagent causing this evolution of "spirit" was designated the ferment, whilst under putrefactio we are to recognise the gradual decomposition of inorganic substances. It should be remembered that the various products due to vital activity were, until as late as 1828, considered outside the pale of experimental science. In that year Wohler synthesised urea, and thus broke down the barrier that had resisted the attacks of many ages. The hazy ideas anent the differences between what we now, for the sake of convenience, call organic and inorganic chemistry, are well illustrated in writings and sayings attributed to the leading thinkers of the dark ages. Basilus Valentinus, in writing the results of his experiments on fermentation, declares that alcohol is always originally present in the fluid, from which it is subsequently obtained, but that it is only by a process of purification, or as we should now say, fermentation, that the alcohol is freed from other substances, and is thus able to exhibit its characteristic properties. He compared the process to combustion, and plainly tells us his researches were directed towards the discovery of an universal ferment, in fact the lapis philosophorum of which so much was expected.

Libavius, a dim and obscure individual, looms forth from the year 1580, or thereabouts, with an idea which one, Stahl, evidently pondered deeply over. He remarks that somehow or other the substance undergoing fermentation must have an affinity with the cause of its decomposition, or as this cause was named, the ferment. Libavius possessed none of the data accumulated by modern science, anent enzymes and zymes, but can we not here discern the germ of one of the latest theories of fermentation, that proclaimed by Emil Fischer of Berlin, and known to science as the Schloss und Schlussel (Lock and Key) theory?

Turning now to the pages of Hoefer, Lavoisier, or Kopp, we find an account of a great man, Van Helmont, who, born at Brussels in 1577, followed the vocation of journeyman physician, and beguiled his leisure hours with much experiment and writing. The knowledge possessed by Van Helmont of various gases was probably far in advance of that held by his contemporaries, but, like the earlier alchemists, he was but a poor master of descriptive art. However, it is to him we owe the word "gas," borrowed or derived from the

German term "geist," signifying "spirit." Van Helmont tells us of his "gas sylvestre," observed rising from beer and fermenting liquids of various kinds, and was the first to clearly distinguish between this gas (carbon dioxide) and the alcohol remaining in solution. To him we owe the dictum, fermentum volatilíset, quod alias in carbonem mutatur, and in his "Opera omnia," published in 1707, together with, as Huxley remarked, a very needful "Clavis ad obscuriorum sensum referendum," may be found much of interest concerning the learning of his times. Alcohol meant not only spirits of wine, but various other things as well, a fact we may convey by quoting Nathan Bailey's definition. "Alcohol," says this early lexicographer, "is the pure substance of anything separated from the mere gross, a very fine and impalpable powder, or a very pure, well-rectified spirit." Van Helmont was fain to attribute to ferment vitality the origin of all animals, whilst the late Julius von Sachs records in his "History of Botany" the belief of Dedu, who, in 1685, evolved similar ideas regarding the vegetable world. We must not pass over the learned distinction of Silvius de la Boe who threw much light on the knowledge of the sixteenth century, by distinguishing between the nature of gas evolved during fermentation and the evolution discerned when acids are added to alkalies. The first he regarded as incidental to the process of decomposition, whilst the latter attended the formation of a definite chemical compound.

Johann Joachim Becher made the discovery that only sweet substances are fermentable, and that, contrary to the theory of Basilus Valentinus, the alcohol produced was a new substance, arising from the act of fermentation. He makes, also, many sagacious discriminations between putrid decompositions and alcoholic fermentation, but was never quite able to shake off the influence exerted by the fascinations of alchemy. Ernst Stahl, however, whose thoughts lie recorded in a curious old German work, published in 1734, may be defined as a chemist, in contradistinction to a follower of alchemy and its wild alluring dreams. "A body," says Stahl, in the work alluded to, "which is undergoing decomposition is able, when brought into contact with another body not yet decomposing, to excite in this new body a similar process of breaking up; or the vibrations which are going on in the first body are able to communicate themselves to a second body of like nature, which was previously in a quiescent condition." In these words it is easy to discern the germ-thoughts destined to be afterwards enlarged upon by Justus von Liebig, and in some measure by that acute mathematician J. von Naegeli. And, further, Stahl set in motion a branch of knowledge nowadays much advanced, to wit, that concerning the spread of diseases by contagion and infection.

The study of organic structures and materials from a chemical standpoint dates from the year 1701, when Hermann Boerhaave was appointed Lecturer in Medicine, and, later, Professor of Chemistry and Botany, at the University of Leyden. Geber, as we have seen, devoted his life to researches among the inorganic materials around him, and had, doubtless, distilled, sublimed, and precipitated every suspicious-looking mineral or fluid that crossed his path, and now Boerhaave, nearly seven centuries afterwards, proceeds to distil, sublime, and collect from organic sources. This great master directed his attention, like all other great men of science, to the mysteries of fermentation and putrefaction, arriving at the conclusion that only substances of vegetable origin undergo fermentation, whilst animal matters suffer putrid decomposition.

The chemical knowledge surrounding fermentation takes its starting point from the year 1774, when Priestley and Scheele, independently, discovered oxygen. By consulting Priestley's autobiography we learn how his great discoveries were inspired by a visit to a brewery, which happened to be situated in close proximity to his residence. His curiosity was aroused by observing the bubbles of gas that ascended through the beer during the process of fermentation. This gas was carbonic acid, and with it Priestley manufactured the first bottle of so-called soda-water.

Lavoisier first studied fermentation from a rational point of view. This great chemist observed how, during the progress of fermentation, sugar was decomposed, and he regarded this decomposition as the breaking up of a complicated oxide, to wit, sugar, into substances containing less oxygen. These substances, formed in normal fermentations, were deemed by Lavoisier to be alcohol, carbonic acid gas, and acetic acid, and if we turn over the pages of his "Elements de Chemie," which work was translated by Robert Kerr in 1790, we shall find various quantitative analyses, worked out by the reformer. They do not, of course, bear well the search-light of modern criticism, but in later years, Gay-Lussac and others arose to set such matters aright, and to give us accurate empirical formulæ for both alcohol and sugar.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

IS THE STELLAR UNIVERSE FINITE?

TO THE EDITORS OF KNOWLEDGE.

SIRS,—With regard to the correspondence on the above subject which has recently appeared in your columns, I would beg to point out that there appears to be some misapprehension in the minds of your correspondents regarding the relation of the "Galaxy" to *the whole visible stellar universe*. The general opinion, I believe, is that the Galaxy (to which our sun belongs) is merely *one* amongst many huge star-groups, which, owing to their very great distance, and to the fact that we are *outside* of them, appear to us as star-clusters, and sometimes possibly as nebulæ. If it is intended to confine the discussion to the "Galaxy" alone, then I may say that its general shape, and our position in it—but not, so far as I am aware of, its mean depth or dimensions—are fairly well understood. If the *whole* of the visible stellar universe is to be included, then the question wears a different aspect entirely, and becomes more formidable than I should care to deal with.

ARTHUR ED. MITCHELL.

A LARGE METEOR.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I hope other of your readers besides myself observed a large meteor which was visible here at 8.10 p.m. on the 5th inst. When I had my attention called to it, it appeared to be moving rather slowly east to south, about parallel to the earth's surface, and it disappeared with a pale green flash of light, leaving a dull red spark. It was quite daylight as well as moon-light at the time. W. EARP.

Leicester, May 12th, 1900.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

DUCKS ASSUMING DRAKE'S PLUMAGE.—On a pond at the Red House, near here, there are two semi-wild ducks (*A. boschas*) in complete drake's plumage. Colonel Taylor, their owner, who bred them himself, tells me they are six years old, but only assumed their present dress two years ago, and like the real drakes, partly lose their male attire in the autumn. I have known hen pheasants assume a good imitation of the cock's plumage, but these two ducks have adopted a perfect drake's dress.—JOS. F. GREEN, Benacre Hall, Wrentham.

FOWL AND RABBIT.—In October, 1899, a keeper here saw one of his hens attacked by a rabbit. The hen in its fright got jammed between some wire netting and a tree, so could not move. Before the keeper could come to the rescue the rabbit had plucked most of the feathers from the bird's back. The idea is that it was a doe rabbit who wanted to line her nest with feathers.—JOS. F. GREEN, Benacre Hall, Wrentham.

SUMMER MIGRANTS.—I did not see a swallow this year till Easter Sunday, April 15th; this I consider late, but was probably caused by the long continuance of cold weather. On Easter Monday I saw quite a strong flight of swallows, some sand martins being with them. On the 19th the cuckoo was heard here, and on the 21st I heard the wryneck (the cuckoo's mate). An informant tells me he heard the nightingale about a week before this date. On the 25th I heard the sedge warbler, and on the 28th I saw the first swift and the first house martin.—E. SILLENCE, Romsey, May, 2, 1900.

Report on the Movements and Occurrence of Birds in Scotland during 1899. By T. G. Laidlaw, M.B.O.U. (*Annals of Scottish Nat. Hist.*, April, 1900, pp. 70-87). This is a very useful report compiled from the notes of a number of observers in various parts of Scotland. The author regrets a slight decrease in the number of observers, as well as in the extent of their observations, as compared to the returns for 1898.

Chiff-Chaff in Barra (*Annals of Scottish Nat. Hist.*, April, 1900, p. 121.) Mr. W. L. Macgillivray records that two specimens of *Phylloscopus rufus* were shot on Barra on November 18th and 20th, 1899. The Chiff-Chaff has hitherto been but doubtfully recorded for the Outer Hebrides.

Long-eared Owl in Barra (*Annals of Scottish Nat. Hist.*, April, 1900, p. 121). Mr. W. L. Macgillivray reports the occurrence of a bird of this species on Barra, on October 28th, 1899. This bird has been recorded but very rarely from the Outer Hebrides.

The Cuckoo: A Study. By Rev. E. A. Woodruffe-Peacock, L.TH., F.L.S., F.G.S. (*The Naturalist*, April, 1900, pp. 99-108.) This is an interesting essay on the habits and notes of the Common Cuckoo.

Ornithological Notes from Norfolk for 1899. By J. H. Gurney, F.Z.S. (*Zoologist*, March, 1900, pp. 97-115.) This forms a record of bird movements and occurrences in Norfolk—an exceedingly useful annual contribution to the pages of our contemporary.

The Hawfinch as a Durham Bird. By J. W. Fawcett. (*The Naturalist*, April, 1900, pp. 113 and 114.) Mr. Fawcett gives a brief history of the occurrence of the Hawfinch in the County of Durham, where it is decidedly increasing in numbers as it is in other parts of England.

Water Pipit (*Anthus spipoletta*) *in Sussex* (*Zoologist*, June, 1900, p. 278). Mr. N. F. Ticehurst records that a female specimen of this rare visitor to England was shot by a boy on February 19th near St Leonards.

Bird Notes from North-east Lincolnshire during the Autumn Migration of 1899. By G. H. Caton Haigh. (*Zoologist*, May, 1900, pp. 201-212.) The autumn of 1899 was not a remarkable one either for great "rushes" of migrating birds or for any great rarities. Mr. Haigh gives a concise account of the movements of the birds in Lincolnshire.

Natural History Notes from Yorkshire for 1899. By Oxley Grabham, M.A., M.B.O.U. (*Zoologist*, May, 1900, pp. 229-236). These notes are chiefly concerning birds.

Breeding of the Shoveler (*Spatula clypeata*) *and of the Garganey* (*Querquedula circia*) *in Kent* (*Zoologist*, June, 1900, p. 279). It is very satisfactory to learn from Mr. N. F. Ticehurst that both of these ducks have bred in Romney Marsh this year. Both the birds are rare breeders in England, the Shoveler especially so. But both birds are no doubt increasing as a breeding species, and it is to be hoped that with a little more protection from owners of the land they may be induced to appear regularly where they now only visit occasionally.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Notices of Books.

"Horns of Honour, and other Studies in the Bye-ways of Archæology." By Frederick Thomas Elworthy. xii. and 315 pp. (John Murray.) 10s. 6d. net. Judged by the canon of pedagogics, which one naturally associates with the name of Herbert, that good teaching must maintain the interest of the pupil in the subject under consideration, Mr. Elworthy's book must be given high praise, for, even throughout the discussion of subjects where many would consider it impossible to develop interest, he always succeeds in retaining the reader's attention. The accounts of the evolution both of "horns of honour" and "horns of the devil," with their plenitude of anecdote and their liberal accompaniment of illustration, abound with evidence of the author's industry in research and of his power with the pen. What we now call crests were, in the Middle Ages, worn as ensigns of high distinction, especially in personal prowess, and few were they who attained unto them; but, says Mr. Elworthy, they have now sunk to be mere fantastic ornaments of the vulgar and the nouveau riche. Starting probably with the idea of the cock's comb, man has, at different times, invented and elaborated wonderful forms of head-dress, which are in the volume before us described in detail. The crests which can be traced back to the shape of the crescent moon seem to be legion but this is not the place to attempt an enumeration; the interested reader must be referred to the book under notice, where he will find them described—down to the widely divergent form seen in the crown of Kaiser Wilhelm. The modern representative of the crescent, not used as a cranial ornament, but for occult reasons of different kinds, is the horse-shoe, which so many use to bring good luck. Sometimes the horn of honour has been turned to base purposes, as Shakespeare knew, for Jaques' song in "As You Like It" runs—

> "What shall he have that killed the deer?
> His leather skin, and horns to wear.
> Take thou no scorn to wear the horn;
> It was a crest ere thou were born.
> Thy father's father wore it,
> And thy father bore it."

The section on "Horns of the Devil," with its biography of this interesting personage, provides a number of quaint tit-bits. There is evidence, we find, that popular imagination made the devil black as early as the death of William Rufus. Church bells were originally intended to keep the devil from church, and the cock was placed on the highest point for the same purpose, whilst the presence of gargoyles is to be similarly explained. The latter half of the volume is concerned chiefly with the hand, or as Aristotle called it the "tool of tools," and the various ways in which the hands have been used symbolically provide plenty of material for demonstrating the extent of Mr. Elworthy's work in collecting and recording data in a somewhat obscure subject.

"Modern Italy, 1748—1898." By Pietro Orsi. xxiii. and 404 pp. (T. Fisher Unwin.) 5s. This latest addition to the deservedly popular "Story of the Nations" series, is from the pen of the distinguished Professor of History in the R. Liceo Foscarini Venice. The translation of the work has been done by Mary Alice Vialls with sympathy and judgment, the result being that the English reader can now study without trouble the history of the lives and work of the pioneers of modern Italy, and become familiar with such commanding personalities as those of Charles Albert of Carignan, Camille Cavour, and many others, of whom the average Englishman knows next to nothing. It is a little strange that while so many of our countrymen are conversant with Italian art and scenery, and know a great deal about the classic remains which command the attention of every scholar, so little interest has hitherto been developed in the constitutional changes and political controversies that have taken so great a part in Italian life during the last hundred and fifty years. It is hoped the volume before us will do something towards remedying this lack of knowledge.

"Evolution by Atrophy." By Demoor, Massart, and Vandervelde; translated by Mrs. Chalmers Mitchell. (Kegan Paul.) 5s. Much has already been written on the many aspects of evolution, and as science in all its branches throws off new shoots as it were, new territory is constantly being appropriated by the evolutionist in his ever widening scheme of co-ordination. Bio-sociological science is in unstable equilibrium. The naturalist with his limited knowledge of social questions too often erects leaning towers with the centre of gravity outside the base, and the sociologist, frequently a theorist with little or no training in biology, sometimes builds his pyramids with the apex downwards. This book, by several authors, aims at presenting a well proportioned view of the structure raised by evolutionists who have prosecuted their investigations into every phase of life and the institutions evolved by civilised communities. It is a work full of interest from first to last, but only a skeleton on which new material may be laid and moulded into shape by competent hands. Great inequality obtains in the several chapters; for example, that on the "Transformation of Organs of Animals" is fairly full, while the section on "Atrophy of Institutions" is somewhat meagre. Nevertheless, it is a work of importance, very suitable for the library.

"Sexual Dimorphism in the Animal Kingdom." By J. T. Cunningham, M.A. xi. and 317 pp. (A. & C. Black.) 12s. net. The phenomena of structure in the animal kingdom may be included, says Mr. Cunningham, under three categories: diversity, polymorphism, and metamorphosis. The present work is devoted especially to the consideration of the commonest case of the second of these divisions, and the arguments presented are chiefly concerned with two special peculiarities of secondary sexual characters, viz., (1) these characters do not begin to appear in the individual until it is nearly adult and sexually mature; (2) they are inherited only by the sex which possesses them. Mr. Cunningham maintains that heredity causes the development of acquired characters for the most part only in that period of life and in that class of individuals in which they were originally acquired. In other words, heredity is a tendency in the new individual to pass successively through the same stages of growth as its parent. The theory of evolution put forward, which the author claims as new and original, is stated as follows: "that the direct effects of regularly recurrent stimulations are sooner or later developed by heredity, but only in association with the physiological conditions under which they were originally produced." In opposition to Weismann, the question of how the inheritance of acquired characters can be produced is not discussed; in the author's words, "it is a fact that the modifications with which I have to deal are hereditary, and my object is to produce inductive evidence that they were determined by special stimulations." After defining his position and setting forth the explanation he has to offer, Mr. Cunningham reviews the facts which have been observed in the chief divisions of the animal kingdom, the successive chapters being concerned with Mammals, Birds, Reptiles and Amphibia, Fishes, Insects, and lower sub kingdoms. It is hardly our province to refer in detail to so highly specialised a piece of work as that contained in this volume. Moreover, there is, after all, only a comparatively small amount of material yet available on which to build theories, and it may well happen that the accumulation of further data will lead to a necessity for a restatement of the case—a contingency fully recognised by the author. However this may turn out, Mr. Cunningham's work is one that claims, and will doubtless receive, the serious consideration of biologists.

"The Structure of the Brain." By Albert Wilson, M.D. (Elliot Stock.) Illustrated. "This work is a re-issue of a more expensive book entitled 'The Brain Machine' issued some time since." The dominant note in our author's theme is that we are only machines, the victims of fate, yet so complex that there remains much at present unknown. "It is no use fighting a fractious, self willed child. Its brain-cells want cleaning and repairing." "After meals we are sleepy, because the blood has left the brain for the abdomen." "Our optic centres absorb it (experience) as a photograph, which we recall every time we are exposed to that small danger." In this manner Dr. Wilson deals with all the ordinary phases of human life, and he is often very happy in his concise mode of expression. The book is exceedingly interesting, and is sustained throughout by exact scientific knowledge.

"A Treatise on Crystallography." By W. J. Lewis, M.A. (Univ. Press, Cambridge.) Crystallography, at the best, is not an attractive study except to those who are well equipped with the elements of geometry and trigonometry, and who have, moreover, an inordinate love for the ungainly nomenclature employed in the classification of crystals. Professor Lewis has imparted a still more chilling aspect to the subject by his rigid mathematical treatment throughout, and the book certainly forms a programme of serious work. We observe that the notation for the crystal forms, the treatment by stereographic projection, and the anharmonic ratio of four tautozonal faces, with which the late Professor Miller's name is associated, have been adopted. Naumann's symbols, so expressive of the geometrical relations of the various rhombohedra and scalenohedra, are employed. The index is good, containing as it does so many names which are invaluable as a means of reference. Particular care has also been bestowed on the numerous figures, and the student's power of solving crystallographic problems may receive a great impetus through the prominence given to the methods used in making diagrams.

"The Strength of Materials." By J. A. Ewing, F.R.S. (Univ. Press, Cambridge.) Illustrated. Professor Ewing's book is remarkable chiefly for conciseness. He knows how to express in a nutshell, as it were, what is really necessary to be said, and does not pad his pages with theories which, like old machinery, have become loose in the joints. Consisting, as one would expect, very largely of so called graphical statics, he handles the representation of forces by lines and their interpretation by formulæ with admirable skill, and a student who is fortunate enough to gain possession of this volume will have the "open sesame" to all those engineering problems immediately concerned with the nature and effects of stresses in the several parts of girders, bridges, beams, and other structures. It is not, however, a beginner's book. To keep pace with the Professor in the present treatise—a lecture room treatment of the subject accompanied by laboratory and drawing office work—the student must have inured himself to the many difficulties which mathematics, elementary mechanics, and physics present, before he can hope to tilt with success at the windmills here erected. Apparatus as used at Cambridge is described and figured. Tension, torsion, crushing, shearing, and the means of obtaining their numerical equivalents—these, and the like, are plastic in the author's hands, and he has put them in attractive form for such as have completed the essential preliminaries.

There are always numbers of photographers who like to use a small apparatus but want to get a good sized picture; both these desires can be satisfied in the "Nydia," a neat folding put into the pocket camera which Messrs. Newman & Guardia have recently brought out.

BOOKS RECEIVED.

Prehistoric Times. 6th Edition. By the Rt. Hon. Lord Avebury. (Williams and Norgate.) Illustrated. 18s.

Directory for Science and Art Schools and Classes, S. and A. D., 1900-1901. (Eyre & Spottiswoode.) 6d.

Hygiene. By R. A. Lyster, B.SC. (Clive.) 2s.

Electric Batteries. Edited by Percival Marshall, A.I.M.E. (Dawbarn & Ward.) Illustrated. 6d.

The Proposed National Antarctic Expedition. By Wm. S. Bruce. (Pamphlet; reprinted from the *Scottish Geographical Magazine.*)

Feilden's Magazine. June, 1900. 1s.

A Little History of South Africa. By Geo. McCall Theal. (Unwin.) 1s. 6d.

In Birdland. By Oliver G. Pike. (Unwin.) Illustrated. 6s.

Comparative Anatomy of Animals. By Gilbert C. Bourne, M.A. (Bell.) Illustrated. 4s. 6d.

Chemistry: An Exact Mechanical Philosophy. By Fred. G. Edwards. (Churchill.) 3s. 6d.

Annales de L'Observatoire National D'Athenes. Tome II. By Démétrius Eginitis, Directeur.

Results of Meteorological and Magnetical Observations, Stonyhurst College Observatory, 1899.

Etching on Metals.—Useful Arts and Crafts Series. (Dawbarn & Ward.) 6d.

Photography in Colours. By R. Child Bayley. (Iliffe.) 1s. net.

Leeds Astronomical Society—Journal and Transactions, 1899. (Wesley.)

Liverpool Observatory, Bidston.—Report of the Director, 1899.

Historical and Literary Essays. By Lord Macaulay. (Ward, Lock.) 2s.

The Story of Bird Life. By W. P. Pycraft. (Newnes.) 1s.

Electric Lighting. By A. A. C. Swinton. (Crosby Lockwood.) 1s. 6d.

Local Particulars of the Total Eclipse of the Sun, 1901, May 17-18. (Nautical Almanack Circular, No. 18.)

ASTRONOMY WITHOUT A TELESCOPE.

By E. Walter Maunder, F.R.A.S.

VI.—THE MILKY WAY.

The short nights of midsummer do not in general give much opportunity to the Astronomer. But twice in the year the most wonderful of all celestial objects stretches itself across our English zenith and sweeps downwards to either horizon. This is that

> Broad and ample road whose dust is gold
> And pavement stars, as stars to thee appear,
> Seen in the Galaxy, that Milky Way,
> Which nightly as a circling zone thou seest
> Powdered with stars."

Its sweep at midnight in mid-July is from the north-eastern horizon where the constellation Auriga is just rising, through Perseus and Cassiopeia on to Cygnus in the zenith; descending again on the other side through Aquila, Serpens, Sagittarius and Scorpio to the horizon in the south-west. The second time when it crosses the zenith is at midnight in mid-December, when it sweeps upwards from the south-eastern horizon in Argo, between Orion and Gemini to the zenith now marked by the constellation Auriga; from whence it passes downwards through Perseus and Cassiopeia to the north-west horizon where the constellation Cygnus is setting.

The Galaxy is no modern discovery. Ptolemy of Alexandria has handed down to us a very full and precise description of it, and it has caught the attention and stirred the imagination of races even as savage as the Australian black fellows. It has been thought of as the roadway of the Gods by which they passed from their halls of eternal light when they wished to visit this nether world of ours; or it is "Die Jakobsstrasse," the mystic ladder which the patriarch saw in his dream at Bethel, up and down which the angels moved.

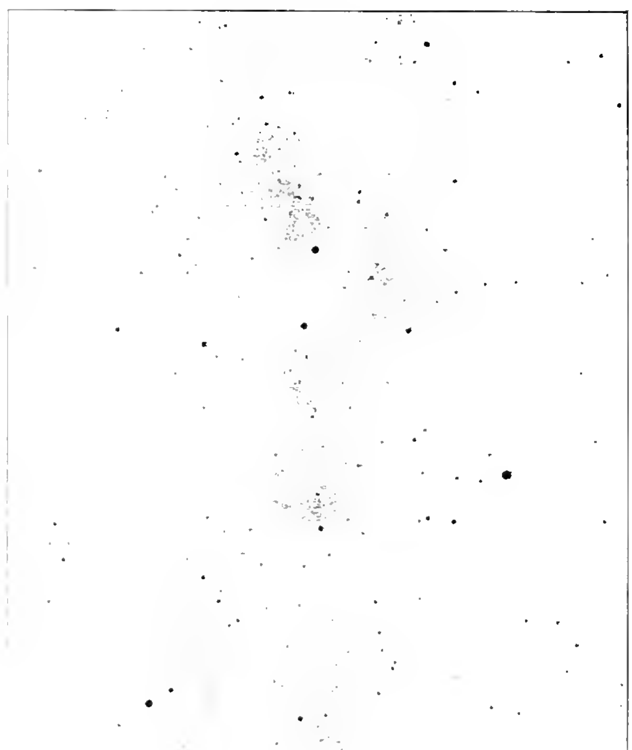
Ptolemy and the Greek Astronomers had recognized two leading facts concerning it. One, that it marked out a zone in the sky, the centre of which was nearly a great circle; the other, that it was not equal and regular everywhere but varied in different regions, in breadth, in brightness in colour, in distinctness, and especially that in some places it broke up into two distinct streams. So much therefore was known about it long before the invention of the telescope, and though it gives to our greatest telescopes their most gorgeous starfields, though in some portions it still defies the efforts of our most powerful instruments fully to resolve it, though its characteristic formations are only brought out when we are dealing with stars far fainter than can be individually detected by the unaided sight, yet the Milky Way as a whole is essentially a naked eye object.

The dwellers in cities and towns, smoke-veiled and flaring with arc lamps or incandescent lights, must abandon all hope of a really intimate knowledge with the delicate structure of the Milky Way. But there are many and many stations in this our island,—lone country houses, little villages,—upon which stars of the short dark summer night will shine down like silver points set in ebony. The faint twilight, visible all night long above the northern horizon, will not interfere with the darkness of the zenith and the south. The evasive moon recognizes that the season belongs of right to her more powerful brother, and either does not show herself at all, or timidly skirts the south as if anxious to escape notice. So though the summer hours of darkness are so few, sufficient of them may be utilized for so delicate a study as that of the Milky Way.

The reason why it is so pre-eminently a naked eye object is easily seen. The field even of a comet-seeker or any other telescope of wide-field and low magnifying power deals with so inconsiderable a fraction of the whole sky. It is impossible in the telescope to mark out the boundaries of the Way; to see where it radiates and divides; where it reunites and condenses again. It can only be examined piecemeal, a very small fraction at a time—"the wood cannot be seen for the trees." It is necessary, therefore, if we are to gain any adequate knowledge of the structure of the Milky Way as a whole, that we should supplement telescopic and photographic examination by the most careful and thorough scrutiny with the unassisted sight.

This is astronomical work of a high order of importance which has been very seldom adequately attempted. The names of Heis, Bœddicker, Easton and of a very few others, occur in this connection, and from the nature of the case, the difficulties of the work being great, it is most important that their observations should be continually repeated.

It is not my intention in these papers, either to describe what other observers have seen or to give any regular history or summary of observations. That has been done most excellently before. Nor do I wish to describe what an observer might be expected to see for himself, since I fear in many cases the reader would content himself with the description. My intention is simply to give such merely general indications of the work which may be attempted and the manner in which it may be set about, that those who wish so to do may



Via Lactea. Borealis 1. Scutum-Cepheus.

themselves undertake observations which, so far as they are concerned, may be original.

Given the absence of the moon, a suitable time of the year, and a thoroughly dark clear night, and even the most casual observer will at once perceive that the Milky Way is a most complex object. In one place we find it broad, and diffused; in another it narrows almost to disappearance. Here the outline will be sharp; there it is fringed out into faint filaments. In some places it coagulates into knots and streaks of light; in others it is interrupted by channels of darkness. It is these details to which I trust that not a few readers of Knowledge will direct their attention.

At this present season I would specially invite attention to that region of which Gamma Cygni is the centre, and which extends from the borders of Cepheus to those of Aquila. Here begins that great rift in the Galaxy the interpretation of which is so essential to a true understanding of its meaning. Here too are seen numerous crossways and side-rifts, not so easily caught as the main channel, but which will be detected as the observer gains experience and skill.

As to the actual method of observation, the first essential is that the observer should be screened from all interference by artificial light. Here comes in the same sort of difficulty that is experienced in drawing the Zodiacal Light, a difficulty to be overcome in much the same manner. First of all the observer must learn thoroughly the principal stars of the district which he is examining; then perhaps the easiest method is for him to dictate to an amanuensis, close at hand, but the light of whose lamp is perfectly shielded from the observer. The latter then might describe the course with respect to the leading stars, of the various rifts or rays, and at the same time should add estimations of the relative brightness or darkness of each respectively. Another method would be to carefully plot the stars down upon a sheet of paper beforehand, which paper might be illuminated by a very faint ruby light, like that used in a photographic dark-room; and the outlines might be drawn on the paper with reference to the stars by its means. The light itself must of course be arranged to shine only on the paper not on the observer's face. It is possible that a card covered by luminous paint might also be useful in this work, but it is not a device which I have myself employed, and I think it would probably dazzle much more in proportion to the amount of assistance it gave than would the faint ruby light. If the luminous paint is used, I should be inclined to recommend either that it be used under a card in which holes have been punched to represent the stars or under a sheet of ground glass or tracing paper or cloth on which the stars have been indicated by black dots.

The beginner should bear in mind that though the Astronomer's rule is to note, that is to record, whatever shines (*quicquid nitet notandum*), nevertheless that he must learn to see before he can record. The careful study therefore of the chosen region of the Milky Way for two or three nights before any drawing is made will not be thrown away, and it should not be forgotten that faint lights are best seen, not from the centre of the eye but from the side, by "averted vision," that is to say. On the other hand, directly the observer feels that he is beginning to get some acquaintance with his subject he should begin to record. The first attempts will no doubt cost some effort, and may prove disappointing, but skill in delineation as well as in detection will come with practice.

PLANTS AND THEIR FOOD. IV.

By H. H. W. Pearson, M.A.

An ordinary fertile soil consists of 75 to 95 per cent. of mineral matter mixed with 5 to 10 per cent. of humus. The mineral particles are of different shapes (*v.* figure), and vary in size from a microscopic dust (clay) to grains large enough to form what we commonly call sand. In addition, there are usually present "stones," larger fragments of rock which form a reserve of mineral nutriment and by their slow decomposition enrich the soil; they are also of no little importance in keeping the soil beneath them moist, at the same time increasing its warmth, for they are quickly heated by the direct rays of the sun.

Soils are divided into numerous classes according to the relative amounts of clay and sand which they contain. A "sandy" soil, for instance, contains over 70 per cent. by weight of sand in addition to clay, lime and other mineral substances and humus. A "clay" soil is composed of the same constituents but in different proportions, half its weight at least consisting of mineral matter so finely divided as to be included under the term "clay." According to some interesting figures recently published by the agricultural authority of the United States, in a gramme-weight* of a sandy soil which contains only 4.77 per cent. of clay, there are about 2 million particles. In another case, a subsoil containing as much as 32.45 per cent. of clay, there are estimated to be 15 million particles in a gramme weight. If the surface-areas of all the particles in a given bulk of soil be added together we should expect the total to be very large. We are therefore not altogether surprised to learn that the average total surface-area of all the particles in a cubic foot of soil is no less than 50,000 square feet. If the soil be sandy, containing only about 2,000,000 particles to the gramme, the total surface area in a given bulk will of course be less than in a clay soil in which are a much larger number of smaller particles. The importance of such calculations as these is seen in dealing with the relation between the soil and the water which penetrates it.

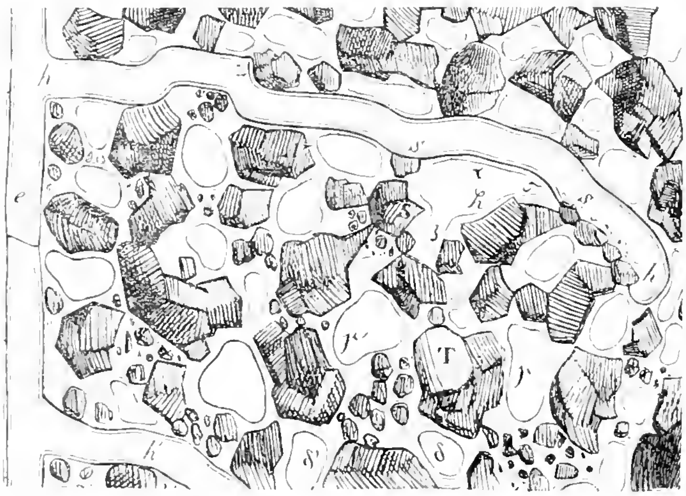
If water in sufficient quantity is poured upon the soil in a flower-pot a part only escapes by the perforation in the bottom of the pot, the rest being retained by the soil. The amount which the soil is capable of holding depends mainly upon two conditions, of which the first is the presence of humus, which, as already pointed out, is a strong absorber of water and adds considerably to the moisture-retaining power of the soil of which it forms a part. In soils which contain only small proportions of humus, the physical properties—in particular the relative sizes—of their mineral particles are of far greater importance in determining their behaviour towards water. As is well known, when a solid is wetted by a liquid, a thin film spreads itself out over the surface, and adheres to it. As rain-water sinks into the soil it penetrates between the mineral particles, each of which becomes surrounded by a thin film of moisture which leaves the general stream and becomes for the time being a constituent part of the soil. It is obvious that the larger the total surface-area of the particles, or in other words the greater the number of particles contained in a given bulk of the soil the more water is thus retained. A clay soil, therefore, being composed of a greater number of minute particles holds more water than a sandy soil whose constituent particles are larger

* 1 gramme = 15·43 grains.

and fewer, and therefore have a smaller surface area. An excess of sand therefore renders a soil dry, and its vegetation suffers in a dry season; if, on the other hand, clay is too abundant the soil holds so much water that it is rendered cold, and being badly aerated becomes acid† and is not well suited to the growth of roots. A soil well adapted to support a thriving vegetation strikes the happy mean between these two extremes, and may have such a composition as the following:—‡

Sand	... ...	from 50 to 70 per cent.
Clay	... ...	,, 20 to 30 ,,
Lime	... ...	,, 5 to 10 ,,
Humus	... ...	,, 5 to 10 ,,

The water thus absorbed by the soil holds in solution various acids formed during the decay of vegetable remains and Carbon dioxide produced in the same process and also given off by growing roots.§ It is therefore a slightly acid liquid which dissolves such of the mineral constituents of the soil as are soluble and renders them accessible to the roots of plants. How great is its solvent action may be imagined when we consider that in a cubic foot of soil it is in contact with 50,000 square feet of mineral surface.



A Vertical Section through Soil, showing the external cells of a root (*e*) giving off root-hairs (*h*, *h'*). The dark angular masses are soil-particles, each surrounded by a film of water (indicated by concentric lines). The light patches (α, β, γ, etc.) are air-bubbles. (After Sachs. Reproduced from Pfeffer's "Physiology of Plants"—Eng. Trans.—by permission of the Clarendon Press.)

The constituents of the soil then are inorganic and organic particles, water and air. The particles are surrounded by films of water which separate them from their neighbours. The water so held is in communication over wide areas, and as its dissolved contents are removed at one point by roots or other agents the deficiency is made good from the surrounding area. A plant therefore does not necessarily obtain the whole of its mineral food supply from the soil in contact with its roots, but is able to draw supplies from a wide area, the transport being effected by the soil-water. Air-bubbles entangled among the particles and their films supply the Oxygen necessary for the respiration of the roots: it is to be noted that this subterranean air differs considerably in composition from that above ground in that it contains a larger proportion of Carbon dioxide derived from the decay of vegetable matter in the soil.

The water which percolates through the soil is still further affected by the remarkable power which the latter possesses of withdrawing from solution certain substances which are dissolved in it. If some garden soil be placed in a funnel and a water-solution of common salt (sodium chloride) poured over it, the water which runs away contains less salt than the original solution. Some of it has been absorbed (or "fixed") by the soil. This property of the soil has been constantly used in obtaining drinking water from impure sources. When the Egyptian forces were besieging Cæsar in Alexandria (B.C. 47), they fouled the wells of the city with sea water. In the emergency, Cæsar caused pits to be dug in the sandy beach and the water which oozed into them from the sea was "not altogether unfit for drinking."‖ Bacon relating this incident says,¶ "Cæsar mistooke the Cause; For he thought that all Sea-Sands had Naturall Springs of Fresh Water. But it is plaine, that it is the Sea-Water; because the Pit filleth according to the Measure of the Tide: and the Sea-Water passing or Straining thorow the Sands, leauth the Saltnesse." This is a classical example of the fixation of dissolved substances by the soil, and is additionally interesting in that it received the notice of the great Elizabethan philosopher. Otherwise, however, it is not so good an illustration as might be wished, for sand is less powerful in absorbing substances from solution than almost any other soil; and of the substances which are removed from their solutions by soil, common salt is affected to a much less extent than are many other mineral compounds. Humus and clay soils possess this property in a very high degree, and in comparison with them the power of absorption possessed by sand is very small indeed. Potash, Ammonia, and Phosphoric Acid, and compounds containing them, are removed from their solutions by the soil to a much larger extent than are any other substances. Magnesia, Soda and Lime are also absorbed to some extent, while Sulphates, Chlorides and Nitrates are very slightly or not at all affected.

Nothing like a complete explanation of these interesting facts is at present forthcoming. The absorption of a salt from its solution by the soil is due to more or less complicated chemical or physical changes the nature of which is but little known, and indeed need not here be considered. The fact which is of importance as regards the food supply of a plant is that certain substances, in particular Potash, Ammonia and Phosphoric Acid, important constituents of the mineral food of plants, are taken up by the soil from their solutions. In what form they are stored in the soil is not known but it is certain that in their "fixed" state they form a reserve supply. The soil-water, as we have seen, is a weak solution of the mineral food substances; as a small quantity of any of these is removed by the roots the deficiency is made good by a corresponding amount of the "fixed" substance becoming again freely soluble and in a condition to be taken up by the plant.

Over other substances, notably Nitrates, the soil has little or no control, and these are carried away by the drainage water out of the sphere of influence of the roots of land-plants. The existence of Nitrates in any quantity in any but an exceedingly dry soil is therefore an impossibility, a fact which leads to the consideration of

† The normal decay of organic bodies is interrupted on account of lack of oxygen; instead, therefore, of the simpler ultimate products of decomposition, there are produced complex vegetable acids.

‡ Fream. "Soils and their Properties."

§ KNOWLEDGE, May, 1900, p. 102, footnote §.

‖ Merivale. "History of the Romans under the Empire," II. (1873), 319.

¶ "Sylva Sylvarum" (1628), 1.

the sources whence the vegetable world obtains its Nitrogen.

It has already been noticed that protoplasm, the "living substance" of all organic beings, is composed of the complex Nitrogen-containing bodies which we call "proteids." Nitrogen, then, is a constituent of the protoplasm itself, to say nothing of other substances found in plants which also contain it; hence we must regard it as a food element of primary importance. In considering the assimilation of Carbon by plants, we saw that an important *rôle* played by vegetable life in the world's economy is the formation of complex Carbon compounds from Carbon dioxide, in other words the raising of Carbon from an inorganic to an organic state in which alone the animal is able to assimilate it. With regard to Nitrogen we find that plants play an equally important part. The animal can only assimilate Nitrogen when it is in the form of complex organic substances such as proteids. Plants make use of simpler organic compounds, inorganic substances such as Nitrates or even (the lower forms of vegetable life) of free Nitrogen itself. By the plant, the element or simple compounds containing it are built up into organic forms such as can convey Nitrogen into the animal system. The waste products of the animal body—living or dead—upon their decomposition, yield up the Nitrogen in simpler forms which are again ready to be assimilated by the plant.

A few plants—such, for example, as our British insect-eating Sundews and Butterworts—obtain part of their Nitrogen from the complex proteids and peptones of the bodies of their prey. In this respect, these and other insectivorous plants live after the manner of the animal, that is, they do not build up complex nitrogenous substances from simpler compounds, but make use of those which have been produced by other plants. They, however, form a very small proportion of the vegetable kingdom. Most higher plants, by which we mean those bearing green leaves and conspicuous flowers, obtain their Nitrogen from nitrates and compounds of Ammonia present in the soil, and of these the majority grow best when they are supplied with nitrates. It has been pointed out above that nitrates are very readily washed out of the soil by percolating water. In some experiments at Rothamsted it was found that in each of the four years between 1877 and 1881 an average of 41.81 lbs. of Nitrogen** per acre in the form of nitrates was washed out of the soil and escaped with the drainage water. If we consider that this amount of nitrogen (42 lbs. per acre per annum) would be sufficient to supply an ordinary crop of wheat or barley we shall realise how serious is the loss of nitrate from the soil which occurs with every fall of rain. It is clear, on the other hand, that water-plants growing partially or entirely immersed in natural waters—the accumulations of water which has drained over or through the land—must be well supplied with nitrates.

Since the loss of nitrate from the soil in any but a very dry climate is continuous, we must enquire by what means Nature meets the difficulty of supplying Nitrogen to that large portion of the vegetable kingdom which seeks it in this particular form. It has long been known that the passage of a lightning flash through the atmosphere is accompanied by a combination of Nitrogen and Oxygen of the air and a consequent production of small quantities—very small quantities—of nitrates. These are washed down into the soil and, until they are washed out again, are available to plants. The amount thus produced is, however, infinitesimal compared with the requirements of the world's green vegetation. Atmospheric electricity is, however, responsible for a much larger production of oxidised Nitrogen (nitrate) than results from the spasmodic discharges of thunderstorms. Wherever earth and air are in contact the air is at a slightly different electrical potential from the earth, and in consequence there is a continuous silent electric discharge between them. This discharge is accompanied by the chemical union of Nitrogen and Oxygen and the production of Nitrates. The amount formed in this way at any one place is of course exceedingly small, but the process occurs continuously over wide areas, and it is therefore not difficult to believe with M. Berthelot that an important contribution is thus made to the nitrate-demands of the vegetable world.

Probably, however, the most important of the natural agents in the formation of Nitrates are the numerous but little known microbes which inhabit the upper 9 to 18 inches of clay soils in prodigious numbers. It is probable that the power of oxidising atmospheric Nitrogen is not rare among these lowly organisms, but at present we know of only one which has actually been proved to possess it.†† The organism, which resides in the roots of Leguminous and some other plants, and enables them to make use of the free Nitrogen of the atmosphere, will be noticed when we are considering the functions of roots. Others of these soil bacteria are concerned in the production of Nitrates, not from the free element, but from those vast stores of combined Nitrogen which exist in the soil in the form of humus. It has been believed that the higher plants are unable to absorb and assimilate the complex organic Carbon—and Nitrogen—containing substances which are present in humus. As to this vexed question we are unable to speak definitely. Certain it is, however, that a vast army of minute workers are constantly employed in transfering certain of the products of the decomposition of humus into Nitrates. These bacterial labourers are divided into at least two classes. There are in the first place those which seize upon the compounds of Ammonia which result from the decay of humus, and oxidise them, producing in this way salts called Nitrites which, as their name implies, are related to Nitrates, differing from them in containing less Oxygen. These receive attention from another section of the bacterial inhabitants of the soil, which oxidise them further, the final product being Nitrates which contain Nitrogen in the condition required by the majority of the higher classes of the vegetable world.

We have noticed the principal known methods by which Nature provides for the Nitrate wants of the vegetable kingdom. Under natural conditions these agencies—and perhaps others also, as yet undiscovered—are sufficient to replenish the soil with oxidised Nitrogen—a replenishment which must be continuous to be effective owing to the rapidity with which Nitrates are removed from the soil by rain-water. But under the artificial conditions of cultivation the equilibrium of these relations is upset. In removing from the land his annual crop, the farmer carries off the greater part of the year's supply of potential humus whence the soil looks to be provided with Nitrates—by the action of the soil-bacteria for the coming season. Hence arises the necessity for the application of manures containing Nitrates. The supply of these manures becomes

** Equal to 254 lbs. of nitrate of soda ($NaNO_3$.)

†† Winogradsky. *Comptes Rendus*, 1894, T. CXVIII., p. 353.

smaller, and the need for them larger, every year, a fact which has given rise to disquieting prophecies of coming Nitrogen-starvation and the consequent failure of the world's supply of wheat.‡‡

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.

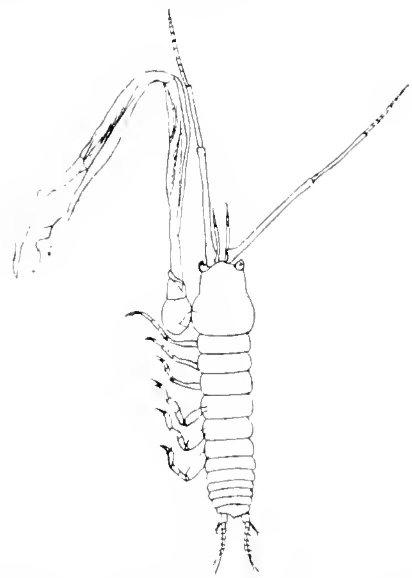
By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

FISH-BEARS AND THEIR KINDRED.

EMERSON was extremely worried by Carlyle's reiterated use of the fantastic expression "gigmanity." Chrysostom's congregation grew tired of his orations against swearing, even while they continued to swear. The persevering student may weary of being told that a woodlouse is a crustacean, before he has become conscientiously convinced that it is one. The old writers were far from accepting the fact. They pertinaciously kept the members of the group apart, under names which to this day have not been discarded, though employed now in a very restricted application, these names being the Greek Oniscus, a little donkey, and the Latin Asellus, which likewise means a little ass. This asinine herd, however, included and excluded many creatures which should have been respectively outside it and within. The woodlouse may be taken as a sort of exemplar or figure-head, to introduce and typify the enormous, diversified, world-wandering order of the Isopoda. The name, meaning equal-footed or like-footed, was coined by Latreille, with a view not to the whole of the order as it is now known, but to a limited number of familiar species, which really have the character implied in the designation. In truth, there are to be found in this, as in many other orders of crustacea, combinations of feet which exhibit no monotony of shape, and are almost grotesque in inequality of size.

The retention of the name, in spite of its being not completely applicable, is a matter of convenience, just as human families retain names such as Webster and Talboys, when their members in general have ceased from weaving the warp and the woof, or from shaping the timber of the forest. Peers and popes and places on a map are allowed to confuse their identity by an unregulated change of name, but science is opposed to such a proceeding. A name is not a definition, and when lawfully given it is not to be lightly altered even on pretence of improvement. The application may be expanded or contracted, just as Rome and Romney may pass through alternations of little and large without ceasing to be Rome and Romney. The Isopoda began with a few genera and species, which during this century have been multiplied into a great horde. Of this number it must be acknowledged that some are separated from the rest by rather trenchant differences. There is a group in which the heart and breathing apparatus are near the head instead of in the caudal region. To these perhaps we ought to apply a name invented by Dana, Anisopoda, which simply means Not-Isopoda. There is an objection to negative names on the ground of their indefiniteness. In this case, for instance, it may be alleged that, apart from the Isopoda, everything in heaven and earth is "Not-an-Isopod." That is true, yet such a word as Anisopoda serves, better than the more recently proposed Tanaidacea, to remind us that the objects so named were once upon a time regarded as Isopoda, and that they have at least some superficial characters in common with that order.

‡‡ Sir Wm. Crookes. Presidential Address to the British Association. Bristol, 1898. "The Wheat Problem." London, 1899.



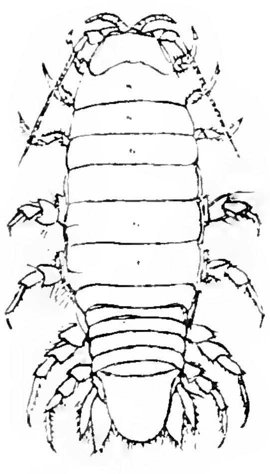
Leptochelia forresti, Stebbing. Feet of right side omitted.

Elaborate details of the structure cannot be given here, but a representation is offered of a species from the family Tanaidæ, without prejudice to the question whether this family, and its companion, the Apseudidae, should be counted as belonging to the order Tanaidacea, the section Anisopoda, or the tribe of the Isopoda chelifera. The species figured, *Leptochelia Forresti*, is found in the West Indies. The enormous claws signalise its masculine sex. They need not inspire alarm, as they are attached to a body only a quarter of an inch long, with jaws as gentle as those of any "sucking-dove."

Passing on, then, to the section of the Euisopoda, that is, the good, the orthodox, the genuine Isopoda, which are accepted always, everywhere, and by everybody, we find a further sub-division into tribes, which may have unforeseen consequences in the future. The natural man is distinguished from the naturalist in this way. The natural man, having with pains and reluctance got into his head a scheme of classification for some group of objects, wishes to have that scheme permanent and unalterable. The naturalist, on the other hand, is aware that fixity of classification means stagnation of enquiry. The more objects he knows about and the more he knows about the objects, the less possible does it continually become for him to fit the new facts into the old framework. Hence come re-arrangement, the disruption of old ties, the formation of fresh alliances, and science which, as above explained, is so jealous to preserve the established names of things, must still be fertile in new terms to express their newly discovered relationships.

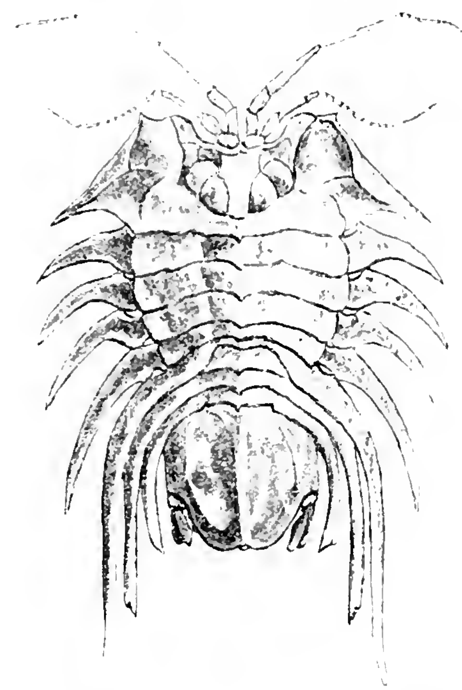
Of the land isopods, embraced at present in the tribe Oniscoida, mention has been made in earlier essays (KNOWLEDGE, Vol. XXI., p. 106, Vol. XXII., p. 285). The insularity of our island is emphasized by the fact that as yet only nineteen species of this group are known in England, Wales, and Scotland. Ireland has a still smaller number, but includes therein the active *Trichonisus viridus* (Koch), not recorded from any British locality on this side of the Irish Channel. In other parts of the world the species are very numerous, and though some are local within narrow limits, others vie with the Anglo-Saxon race itself in range of travel. Their own little legs, though fourteen in number, and occasionally displaying great agility, could scarcely carry them very far within the lifetime of an individual. Some species, which seem not only to attend but to precede the footsteps of man in remote regions, have probably covered the larger distances as an uninvoiced portion of the merchant's exports or the traveller's baggage, and then by making short excursions from the point of arrival have been enabled to assume the attitude of old inhabitants.

Nearest in general appearance to the terrestrial isopods are the Sphæromidæ, which belong to a different tribe, the Flabellifera, a highly important and interesting but rather a miscellaneous group. In it the uropods or tail-feet are lateral, forming with the telson a flabellum or fan, whereas in other isopods (except the Valvifera) they are terminal. The Sphæromidæ till recently were only known as marine. Now they have been obtained from the fresh water of warm springs and inland caverns, the passage from salt water to fresh being, as one may suppose, the intermediate step to a truly wonderful change, from aquatic to subaerial existence. Human beings who try making this change in the reverse order usually find five minutes over long for the experiment. But some of the land isopods are far less sensitive, for I have found a Porcellio immersed on the side of a lock and making no attempt to leave the water, yet quite lively when removed from it, and a recent experiment has shown that a *Porcellio scaber* can remain under water for four or five hours without material inconvenience.



Cirolana borealis, Lilljeborg. From H. J. Hansen.

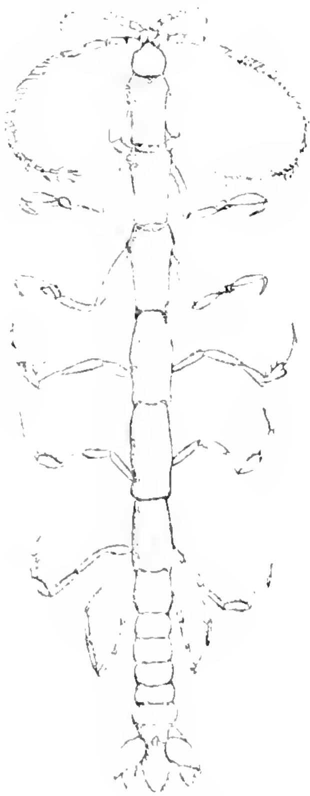
In the same tribe with the Sphæromids are the Cymothoids, of which, if one were a literary fish, one would write with a kind of horror, on account of the appalling diligence which these so-called fish-bears devote to ichthyology. Not contented with persecuting ling and haddock, cod and halibut, they assail with equal fearlessness dog-fish and shark and tunny. An extraordinary feature in the life of some of the Cymothoids is the virtual change of sex which is said to occur, enabling the father of one family to become in turn the mother of another, as though the ordinary marital arrangements were not sufficient to perpetuate their malicious brood. Those, like the Ægidæ, which lead a parasitic life, are furnished with sharp hooked claws for clinging, and with mouth-organs modified for piercing and tearing the skin of their hosts. In the nearly allied Cirolanidæ the claws are not powerfully uncinate, because these species are more vagrant. Their jaws are adapted for biting rather than piercing. They are not less enamoured of a fish diet than the Ægidæ, and they make their meals impartially of the living and the dead. The celebrated Kröyer once found a large codfish riddled by a swarm of *Cirolana borealis*. He hastily secured some in his closed hand, but with equal haste let them go again, for they bit him barbarously and gnawed at his naked flesh without remorse. Nothing could more painfully show the unscrupulous character of these creatures than that they should dare "to bite so good a man," who was grabbing them purely in the interests of science.



Serolis bromleyana, v. Willemoes Suhm. The feet omitted. From the "Challenger" Isopoda.

A passing notice must suffice for the flattened sand-burrowing Serolidæ, a family, so far as known, almost confined to the southern hemisphere, but ranging from shallow water down to a depth of two thousand fathoms. A comparison of the species *Serolis bromleyana*, v. Willemoes Suhm, with the species *Anthelura elongata*, Norman, from the family Anthuridæ, will show what strange contrasts of shape are possible within a single tribe of the Isopoda. In the Anthuridæ the great comparative length and almost linear form of the trunk may first appeal to the attention, but there is more to engage it in the head and the tail, small as they both are. The peculiar folding of one branch of each uropod over the telson produces a certain resemblance to the calyx of a flower. This suggested for the first formed genus the poetical name *Anthura*, meaning flower-tail. At the other extremity the head forms a rather difficult subject for study. At the first glance it might be supposed to vary little in the different genera. But this is not the case. The small closely compacted mouth-organs show important distinctions. In some of the genera they are evidently for perforation and suction, but in others their mode of operation is not so clear, nor in either instance is it known upon what objects they operate. To serve their private ends they very likely use the moral or intellectual quality nowadays described as slimness, in suitable accordance with their slenderness of form. Of the equally curious family Gnathiidæ, completing the tribe Flabellifera, discussion must be held in reserve.

Of the Valvifera a specimen has been already figured (Knowledge, Vol. XXI., p.3). The name of this tribe has reference to the uropods, which fold like valves, or rather meet like a pair of folding-doors, so as to enclose and shelter when necessary the natatory respiratory pleopods. In regard to *Anthura* it was mentioned that the uropods folded over the telson. Here they fold under it, and by a curious modification this which is the last pair of appendages looks as if it might be the first, because it covers the five pairs of pleopods which in order of attachment all precede it. In the family Idoteidæ the legs show tolerable uniformity, but in the co-tribal family Astacillidæ there is often strong diversity between the set consisting of the first four pairs and that consisting of the last three. The hinder group are of normal pattern, adapted for clinging to seaweed or other suitable marine objects. The anterior set are slender and feeble and fringed with setæ. These four pairs are close together and close to the mouth, and are no doubt much concerned with the food-supply. But the first seizure of



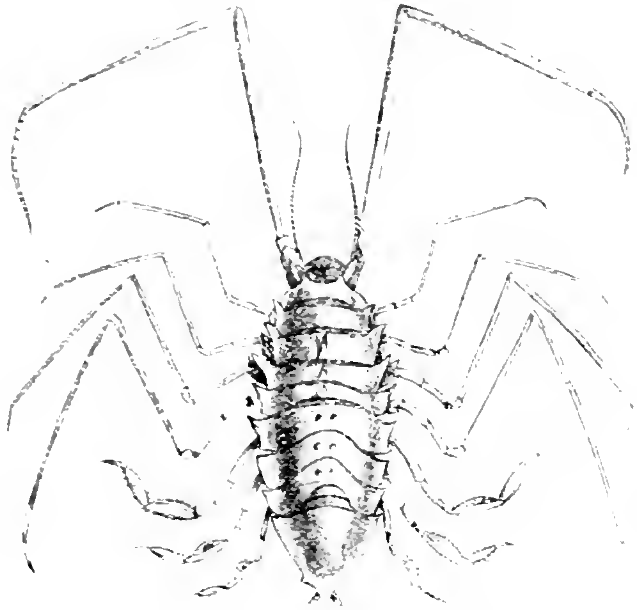
Anthelura elongata, Norman

prey is said to be accomplished by the powerful lower antennæ. In this case, however, the prey will not consist of sharks and dog-fishes, but of minute organisms, such as can be passed on from the antennæ to the setose legs and held within their network of hairs or setæ at the disposal of the selective jaws. The long antennæ in this family have another function beside that of grasping prey. They form a sort of perch to which rows of young ones have repeatedly been found clinging, like wind-waving articles on a laundress's clothes-line. One observer has recorded that "the parent neither testified impatience of their presence nor seemed to suffer any

Astacilla damnoniensis, Stebbing.

inconvenience under the burden." The same observer, however, believed that with rapidly advancing growth the young "certainly proved an annoyance which was ultimately fatal." That the mother either invites or has no wish to hinder the presence of her little ones in so peculiar a situation is evident, for otherwise her long antennæ would be at once and instinctively passed between the fringing hairs of the front limbs, to be cleared, as in this way they habitually are, of encumbering objects. But the habits of crustacea quite forbid the supposition that the mother would permit the rising generation after birth to cause her serious inconvenience, when a simple bending of her antennæ would enable her to brush them off or eat them up.

Omitting from this sketch the strange parasitic tribe of Epicarida or Bopyrida, to which some allusion has been previously made (Knowledge, Vol. XXII., p. 138), we must give a concluding paragraph to the Asellota. In these the uropods are terminal instead of lateral, and in the female the first pleopods are usually consolidated into an opercular plate, thus fulfilling an office performed by the uropods in the Valvifera. Also in the female of the Asellota the second pair of pleopods is always wanting. This tribe includes the extremely common fresh-water species, *Asellus aquaticus* (Linn.), in which the feet are of a fairly uniform pattern. On the other hand, it also includes some of the rarest and strangest species of the whole order Isopoda, and some to which that name by its meaning is the least applicable, inasmuch as the feet show very exaggerated differences of size and shape. An example convenient for illustration is afforded by *Eurycope novæ-zelandiæ*, Beddard, in which it will be seen that the fourth pair of



Eurycope novæ-zelandiæ, Beddard. From "Challenger" Report.

limbs are about thrice as long as the seventh pair. The generic name, signifying broad-oars, refers to the flattening of the penultimate and ante-penultimate joints in the hinder set of limbs; and this widening of the blades is carried in some species to a far greater extent than in the one here figured.

It may seem disproportionate to have given a whole chapter to the Isopoda, which to some readers must still seem an obscure, insignificant and unimportant order. A whole chapter has only sufficed to indicate the barest outlines of classification, the most obtrusive differences here and there in habits and outward form. The internal structure and the minutiæ of the ever varying mouth-organs have been left on one side, with much else. The fact is that the explaining of all that is known on the subject of this chapter would expand into a volume, the exploring of all that is unknown might occupy, amuse, and dignify a lifetime.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

At a recent meeting of the Manchester Microscopical Society Mr. M. L. Sykes contributed a note on the methods that Mr. C. F. Rousselet employs when preserving and mounting organisms so that they shall retain their natural forms with their colours, muscles, etc. Mr. Rousselet exhibited a number of microscopical preparations of Rotatoria at the International Zoological Congress at Cambridge, which claimed special notice for their beauty and the success of the methods he had adopted. Rotifera cannot be killed suddenly, by any known process without contracting violently, and losing all of their natural appearance. To kill and preserve them with their cilia fully expanded and in their natural condition Mr. Rousselet first narcotizes them with a solution consisting of 3 parts of a 2 per cent. solution of hydrochlorate of cocaine, 1 part of methylated spirits, and 6 parts of water. The Rotifers should first be isolated in a watch glass and clean water, and a drop or two drops of the solution added at first, after five or ten minutes another drop should be added, and afterwards drop by drop and very slowly until the animals are completely narcotized. They may then be killed and fixed by adding one drop of an eighth per cent. to a quarter per cent. solution of osmic acid. To clear from the solution they must be washed several times, and then transferred to a $2\frac{1}{2}$ per cent. solution of formaldehyde, and should be mounted in this fluid in hollow ground glass slips. The objects have all the appearance of living animals, the colours, internal structure, and outward form being beautifully preserved in situ.

The current issue ("Zoology") of the "Journal of the Linnean Society" contains, among other articles of interest to the microscopist, a contribution by Mr. H. Wager on "The Eye Spot and Flagellum of Euglena viridis," and a paper by Mr. H. M. Bernard on "The Structure of Porites."

In a record of observations on the microscopic life of Arctic regions, Dr. Levin states that air from numerous localities showed only a few moulds. In water from the sea surface bacteria were always found, but in very small numbers—perhaps one thousand to a quart; while water from glaciers, snow streams, ice and melted snow, also gave evidences of bacteria in small numbers. In water from the deep sea these organisms were more abundant than on the surface. With the exception of a single species of bacterium found in one bear and two seals, the intestinal contents of the white bear, seal, shark, eider duck, and other Arctic vertebrates were absolutely sterile, but bacteria were almost invariably present in the lower marine animals. These observations on germ-free intestines are of special importance and interest, as they confirm the idea of Pasteur and a few others that bacteria are not essential to digestion.

It is a curious fact that among the impurities that have been detected in calcium carbide are microscopic diamonds. These gems are so exceedingly small as to be of no commercial value, but they accentuate the fact that carbon in the crystalline condition can be produced artificially, and give reason to the assumption that some day it will be possible to produce diamonds of a size sufficient to be marketable.

In his Presidential address to the Quekett Society Dr. Tatham alluded to the difficulties attending the use of realgar as a mounting medium. Its high refractive index makes it most useful, but its disadvantages are many and serious. The fusion of the material which is necessary for the mounting process requires the application of great heat. This liberates intensely poisonous fumes, and frequently so distorts the valves of the diatoms that they are seldom found to lie flat on the cooling of the slide. The colour of the finished mount is a deep yellow, and this seriously detracts from the value of the mount for critical examination. This last defect may be partially rectified by the use of suitably coloured screens, of which a polished plate of bright blue glass has been found to be best adapted in aiding in the resolution of difficult tests.

The Cambridge Scientific Instrument Company are introducing an improved model of their well known rocking microtome. Among the advantages that they claim for the new form is the possibility of cutting sections to any required degree of thinness without the risk of the sections either varying in thickness or of being torn on the upward movement of the object.

In the epidermis of man and mammals Professor L. Ranvier has recognised seven distinct layers, which are described to the Royal Microscopical Society as stratum germinativum, filamentosum, granulosum, intermedium, lucidum, corneum, and disjunctum, in the order of their development. The limits are well defined, each layer having distinct physical characters and chemical reactions. These layers are not formed by special elements, however, and a cell originating in stratum germinativum becomes changed and passes into stratum filamentosum and so on through the series.

Mr. J. E. Stead has recently published the results of the work that he has done on the microscopic structure of metals. Experience has made it easy to cut, grind, polish, and etch ordinary metals and alloys, and specimens can now be prepared for the microscope in a few minutes. Mr. Stead's work has yielded some unexpected results. In a recent demonstration pig-iron was shown to have its constituents gathered into separate centres, the carbides being in isolated silvery crystals, while the phosphorus and sulphur compounds were each distinctly separated. A brilliantly polished piece of white pig-iron, containing carbon, sulphur and phosphorus, was then heated until it became purple. Under the microscope the constituents were found to have diverse colours, the iron being of a fine sky blue, the carbides an orange colour, the phosphides a pale brown yellow, and the sulphides a slaty blue. This method of identifying phosphides is a new discovery which will be of great value to iron manufacturers as a simple means of telling whether iron contains phosphorus. The microscope shows that alloys, instead of being homogeneous, as have been thought, are built up of various crystals, and is likely to prove of practical service to metal workers in many ways.

The acetylene flame may be rendered monochromatic by the interposition of a screen of cobalt blue glass between the light and the substage condenser.

The principal uses of a light filter in photomicrography are for the correction of the objective, the increase of contrast in the image.

and the increase of resolving power. Dr. S. Czapski has shown that the greatest resolving power is obtained by using light of short wave length, even the ultra-violet. This is due to the fact that the blue end of the spectrum has the shortest wave length, and the limit of resolving power is one-half of the wave-length of the light used.

In the course of his presidential address to the Quekett Society, Dr. J. F. W. Tatham drew attention to a mounting medium consisting of piperine and bromide of antimony, with which he has obtained very satisfactory results when examining lined tests. The mixture is prepared by combining three parts by weight of piperine and two of antimony bromide, by gently fusing the mixture over a spirit lamp, care being taken not to raise the temperature more than is necessary or it will char and discolour. After the diatoms have been spread on the cover glass in the usual way, a small portion of the mixture is placed between the cover glass and the slide, and gently fused until a thin film of it unites the two surfaces. When the medium is set it must at once be protected from the air, otherwise the salts will decompose. To effect this solid paraffin should be allowed to run between the cover glass and the slide, and the whole finished off with a circle of Hollis's liquid glue.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* KNOWLEDGE.]

NOTES ON COMETS AND METEORS.

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

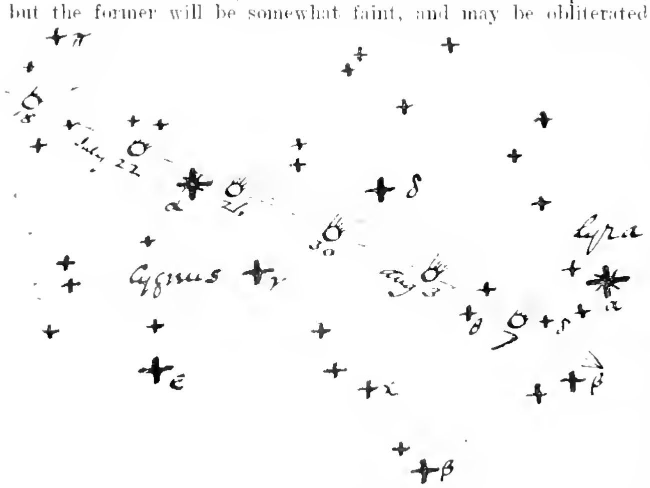
GIACOBINI'S COMET.—This object will be favourably visible in July, passing rather quickly through the constellations of Andromeda, Lacerta and Cygnus. It will be nearest to the earth at the end of the third week in July when it will be about twice as bright as it appeared on the night (January 31) of its discovery. The following is an ephemeris by Berberich (Ast. Nach. 3636, for Berlin, mean midnight :—

Date.	R. A. h. m. s	Dec. ° ′	Distance of Comet in Millions of Miles.
July 2	23 36 32	+ 42 31	125
„ 6	23 12 47	+ 44 21	119
„ 10	22 44 43	+ 45 52	115
„ 14	22 12 29	+ 46 51	111
„ 18	21 37 4	+ 47 7	109
„ 22	21 0 16	+ 46 31	108
„ 26	20 24 19	+ 45 0	109
„ 30	19 51 16	+ 42 42	110
Aug. 3	19 22 21	+ 39 51	113

At noon on July 25 the comet passes 44′ N. of Alpha Cygni, and with a very low power may be seen in the same field of view of a telescope on the nights of July 24 and 25. The position of the star (January 1, 1900) is R.A. 20h. 38m. 1s., Dec. + 44° 55′, while the places of the comet are—

July 24, R.A. 20h. 42m. 2s., Dec. + 45° 52′
„ 25, „ 20h. 33m. 6s., „ + 45° 27′

It will be interesting to view the comet and star if possible, but the former will be somewhat faint, and may be obliterated



Path of Giacobini's Comet amongst the Stars of Cygnus and Lyra, July 18—August 7, 1900.

in the glare from the star. The comet should be looked for with the star out of the field, and then the experiment can be afterwards tried as to whether both objects are visible together.

COMET 1892 II. (DENNING).—M. Fayet, in "Bulletin Astronomique," for March, gives the result of his researches as to the original orbit of this comet. M. Steiner has discussed (Ast. Nach. 3472) the present form of orbit, and concluded that it was hyperbolic. The comet was observed during the 10 months from March 18, 1892, to January 20, 1893. M. Fayet's investigations show that it was originally revolving in an elliptical orbit with excentricity equal 0.998406.

FIREBALL OF MARCH 28.—Prof. A. S. Herschel has compared the various observations of this brilliant object and finds that the most probable radiant was at 182° + 41°, and the height of the meteor about 60 to 38 miles above Kent. But the descriptions of the path by the various observers are inconsistent and lead to different results according to the interpretation put upon them.

FIREBALL OF MAY 5, 8H. 20M.—A very brilliant meteor was noticed by many persons in the strong twilight of May 5, but, as in the case of the fireball of March 28th, the accounts are somewhat discordant and incomplete as regards necessary details. The following are extracts from a few of the reports already published :—

NORTHANTS—Magnificent meteor, considerably larger than Venus. Appeared in S.E. sky, and sailed along the S. sky, crossing the meridian at about the altitude of the celestial equator, and finally bursting 30 degrees S.E. of the moon. Duration 5 or 6 seconds. "It looked like a runaway moon charged with colour."

ST. ALBAN'S, HERTS.—Meteor 4 or 5 times more brilliant than Venus. It was first seen about 10 degrees S. of Arcturus and disappeared about 4 degrees N. of the moon. Duration 2 or 3 seconds. Sky partially cloudy.

BISHOP'S STORTFORD.—Meteor of most startling and brilliant nature spread itself over the zenith. It had a tail 6 degrees in length.

HANDSWORTH, BIRMINGHAM.—Unusually bright meteor in the E. part of the heavens, travelled slowly from N. to S., appearing to take an upward course of about 45° with the horizon.

SYSTON.—"A great luminous ball of fire" seen leaving a trail of light behind it, and moving from E. to W. in an almost horizontal line.

BRIGHTON.—"Extraordinarily brilliant meteor visible towards the N.E. It swept along for some seconds, now hidden behind clouds, now shining out in the intervals towards N.W. where it disappeared."

EBBW VALE.—Fine greenish meteor moved across the S.E. heavens very slowly from S. to N., its path being horizontal.

LIDLINGTON, BEDS.—The body of the meteor was of large size and very brilliant; the tail was of great length. Its course across the sky from N.E. to W. occupied 3 or 4 seconds.

POTTER'S BAR.—First seen in the direction of Arcturus and passed from S.E. to N.W. by W. Sailed across the zenith, and gave the impression of descending rapidly earthwards, the head exploding quite low down.

OXTON, CHESHIRE.—Fine meteor due S. when first seen, and moving slowly towards S.W.; not more than 25 degrees above horizon.

BIRMINGHAM.—Brilliant meteor, twice as large as Venus, "appeared rather low down in E. and was going almost due S." Another observer says it travelled in a horizontal line from E. to W. for about 30 degrees.

WALSALL.—Very brilliant object gliding gently across the heavens and putting Venus completely in the shade.

There are some other accounts. The observers generally describe the object as extraordinarily luminous, and moving rather slowly in a horizontal path from E. to W. across the S. sky. The real path of the fireball was from about 64 miles over Canterbury, Kent, to 43 miles over Hungerford, Berks. Its length of course was at least 112 miles, and velocity about 20 miles per second. The radiant point was a few degrees above the E. horizon at 245° + 5°, but these deductions are mere approximations.

THE COMING OF THE PERSEIDS.—The last 12 nights of July will be almost free from moonlight, and an excellent opportunity will be afforded for observing early Perseids. They certainly begin to arrive in the third week of July, and it is important that the radiant point of the shower should be determined on every night from about the middle of July to the middle of August. Plenty of observations have accumulated for the first half of August and what we now require is a large number of materials for the last half of July. For this purpose the sky should be watched during the whole night, and the path-directions of the swift streak-leaving meteors from the regions of Cassiopeia and Perseus recorded with great accuracy. The positions of the radiant as deduced from the writer's observations in and since 1869 are as follows :—

	α °	δ °		α °	δ °
July 16	16·6	+ 49·8	July 31	33·2	+ 54·4
„ 19	19·7	+ 50·9	Aug. 3	36·7	+ 55·2
„ 22	22·9	+ 51·9	„ 6	40·2	+ 56·0
„ 25	26·2	+ 52·8	„ 9	43·8	+ 56·8
„ 28	29·6	+ 53·6	„ 12	47·5	+ 57·5

Height of a Meteor.—Real paths have been computed at various times for meteors belonging to nearly all the chief showers of the year. But the rich shower of Aquarids discovered by Lieut. Col. Tupman while cruising in the Mediterranean in 1870, and supposed to present an orbital resemblance to Halley's comet, had never supplied a doubly observed meteor the real path of which had been computed. At last, however, a pair of good observations are forthcoming. Prof. A. S. Herschel while watching the sky at Slough on May 5 at 15h. 57m. saw a very long pathed shooting star travelling from 291° + 28° to 176° + 15° in 6½ or 7 seconds, and varying in magnitude from 5 to 2½. Mr. J. H. Bridger, of Farnborough, was watching the sky at the same time and recorded a meteor of 2nd mag. shooting from 300° + 36° to 179° + 34° in 4 seconds. The end was not well seen as a tree partially interrupted the view. Prof. Herschel's observed path extends over 105 degrees, while Mr. Bridger's covers 90 degrees. Prof. Herschel carefully noted the object as it sailed from Beta Cygni to Beta Leonis, and describes it as leaving a streak visible for one second. On comparing the observations it is found that, slightly altering the Farnborough end point (the view of which was very imperfect), they are in satisfactory agreement and enable the real path to be derived as follows:—

Height at beginning	... ...	54 miles, near Sevenoaks, Kent
Height at ending	... ...	49 miles, 9 miles south-west of Cardiff, Bristol Channel.
Length of path	... ...	155 miles.
Velocity per second (adopting 5½s. for duration)	...	28 miles.
Radiant point	... ...	337° ± 0°.

The meteor therefore pursued a very long and almost perfectly horizontal path from east to west, the radiant having but just risen in the east. It is interesting to note that in the "British Association" report for 1875, p. 232, Prof. Herschel gave the date of nearest approach of the orbit of Halley's comet to the earth as May 4, the radiant point as 337° ± 0°, and the meteoric speed as 41 miles per second. The latter element differs widely from the 28 miles per second found for the recent meteor, but its original velocity in space must have been greatly retarded by the resistance of the earth's atmosphere during its very extended flight.

THE FACE OF THE SKY FOR JULY.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 3.49 and sets at 8.19; on the 31st he rises at 4.23 and sets at 7.49. The earth is at its greatest distance from the sun on the 2nd at 1 P.M., the sun's apparent diameter then being 31′ 30″.6.

The Moon.—The moon will enter first quarter at 0.14 A.M. on the 5th; will be full at 1.22 P.M. on the 12th; will enter last quarter at 5.31 A.M. on the 19th; and will be new at 1.43 P.M. on the 26th.

The following are among the more interesting occultations during the month:—

Date.		Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
					°	°		°	°	d. h.
July	8	Delta Scorpii	2.5	11.24 P.M.	100	136	11.54 P.M.	207	180	11 22
,,	9	24 Ophiuchi	5.6	10.50 P.M.	68	57	0.2	290	268	12 22
,,	11	33 Sagittarii	6.0	10.18 P.M.	126	138	11.10 P.M.	212	215	14 21
,,	12	Xi(2)Sagittarii	3.5	0.19 A.M.	110	103	1.18 A.M.	219	202	14 23
,,	14	e² Capricorni	5.2	9.43 P.M.	13	48	10.17 P.M.	306	339	17 21
,,	16	16 Piscium	5.6	11.3 P.M.	16	54	11.42 P.M.	294	330	19 22

The Planets.—Mercury is an evening star, at greatest eastern elongation of 26° on the 4th, and near inferior conjunction at the end of the month.

Venus is in inferior conjunction on the 8th, after which she will be a morning star, arriving at a stationary point in Gemini on the 30th.

Mars is a morning star, in Taurus, rising about 1.30 A.M. on the 1st, and shortly before 1 A.M. on the 31st.

Jupiter may be observed up to midnight. He is near Beta Scorpii during the early part of the month, and is in conjunction with the moon, 1° 35′ to the north, at 1 A.M. on the 9th. On the 15th the apparent diameter of the planet is 39″.4. The satellite phenomena are most interesting. On the 1st (11.39), 3rd (8.55—11.2), 4th (9.2—11.16), 6th (11.23), 10th (8.18—12.19), 11th (10—12.13), 12th (10.25), 17th (8.37—11.10), 19th (9.5—12.20), 20th (8.30—9.35), 24th (8.7—10.8), and 27th (8.7—11.30).

Saturn may be observed throughout the greater part of the night, in the western part of Sagittarius. He will be on the meridian at 11.27 on the 1st, at 10.28 on the 15th, and at 9.21 on the 31st. On the 9th the polar diameter of the ball will be 17″, and the outer major and minor axes of the ring respectively 42″.5 and 18″.9. The northern surface of the ring is visible.

Uranus is above the horizon from the beginning of the evening up to midnight throughout the month. He remains a little to the south-east of Omega Ophiuchi.

Neptune is not observable.

The Stars.—About 10 P.M., at the middle of the month, Perseus, Andromeda, and Cassiopeia will be in the north-east; Cygnus and Pegasus in the east, Aquila in the south-east; Lyra nearly overhead; Corona, Libra and Virgo in the south west; and Ursa Major in the north-west.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of June Problems.

No. 1.

(B. G. Laws.)

[We much regret that, last month, this problem was incorrectly diagrammed. The White Knight at QRsq should be a White King.

The problem is reprinted below; solvers who guessed the mistake need not trouble to repeat their solutions, which will be acknowledged, with any others, next month.]

No. 2.

(W. H. Gundry.)

1. Kt to Kt3, and mates next move.

Correct Solutions of No. 2 received from W. H. Brandreth, W. de P. Crousaz, G. A. Forde (Capt.), Alpha, K. W., H. Le Jeune, J. Baddeley.

K. W.—Too late to acknowledge last month.

W. H. Gundry.—Have sent copy of your two-mover. Your solutions arrived too late to acknowledge. Three-mover appears below.

Otto Schachel.—If 1. Q × Q, the Black Knight moves and will cover the threatened mate at KKt8.

W. Parkinson.—If 1. Q to K5, Q to KKtsq, ch!

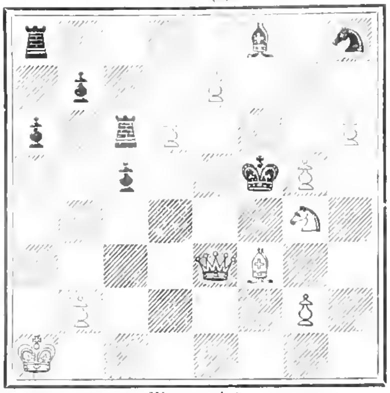
X. Y. Z.—The problem which you send is unfortunately too full of dual mates for publication. For instance the Knight can always mate at Q7 wherever the King goes, and even the threat is a double one. In fact Q × B and Q to Q7 are apparently the only defences free from resulting duals.

PROBLEMS.

No. 1.

By B. G. Laws.

Black (8).



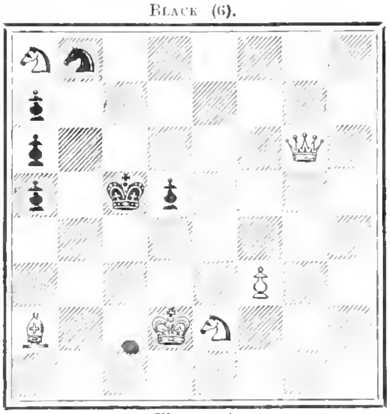
White (10).

White mates in three moves.

No. 2.

By W. H. Gundry (Exeter).

Black (6).



White (6).

White mates in three moves.

Mr. J. K. Macmeikan, of Repton School, honours me by the dedication of the following subtle stratagem:—*White*—K at QBsq, R at KR6, B at K5 and KB7, Kt at Q3 and QB6, P at KR3 and QB2. *Black*—K at QB6, R at Q5, P at KR4 and QR3. White compels Black to mate in seven moves.

CHESS INTELLIGENCE.

Mr. H. N. Pillsbury has beaten all records for blindfold play by engaging in 20 games simultaneously at the Franklin Chess Club, Philadelphia, on April 28th last. His score was won 14, drawn 5, lost 1. Considering that his opponents included such well known players as S. W. Bampton, C. J. Newman, and W. P. Shipley, Mr. Pillsbury's performance must be regarded as brilliant in the extreme. Dr. Zukertort once played 16 games blindfold, but no other player, we believe, has played so many—certainly not more—till Mr. Pillsbury finally eclipsed all previous performances.

A correspondence match of two games is in progress between the Vienna Chess Club and the French Chess Association. The openings are the Four Knights Game and the French Defence. Mr. Steinitz has been playing his own gambit by correspondence with the Liverpool Chess Club, with the view of testing a new departure for White at move 9. Mr. Steinitz was mated on the 34th move.

The Paris international tournament has been making rather slow progress owing to the frequent holidays. The full score will be given next month. Messrs. Lasker and Pillsbury have been in fine form, but the latter lost to Mr. F. J. Marshall, the winner of the minor tournament in London. Mr. Marshall's play has so far been the feature of the meeting. The other players are Maroczy, Burn, Schlechter, Janowski, Tchigorin, Mason, Mieses, Marco, Mortimer, Brody, Showalter, Sterling, Didier, and Rosen. Mr. Blackburne was unfortunately prevented from entering owing to serious trouble with his eyes. Herr Marco is scoring uncommonly well, but Herr Schlechter is losing far more games than is usual with him. Janowski has had a bad time lately, but Mieses is still doing well. Herr Lasker holds the lead and is certain of the first prize.

The score of the following game is from *The Field*:—

White. Schlechter.	Black. Showalter.
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to Kt5	3. Kt to B3
4. Castles	4. Kt takes P
5. P to Q4	5. Kt to Q3
6. B takes Kt	6. QP takes B
7. P takes P	7. Kt to B4
8. Q takes Qch	8. K takes Q
9. Kt to B3	9. P to KR3
10. R to Qch.	10. K to Ksq
11. P to QKt3	11. B to K3
12. B to Kt2	12. R to Qsq
13. Kt to K2	13. P to KKt4
14. P to KKt4	14. Kt to Kt2
15. P to KR3	15. B to K2
16. KKt to Q4	16. P to KR4
17. P to KB3	17. P to QR3
18. Kt to Kt3	18. P takes P
19. RP takes P	19. R to R5
20. K to Kt2	20. B to QBsq
21. KtQ4 to B5	21. B takes Kt
22. Kt takes B	22. Kt takes Kt
23. P takes Kt	23. B to B4
24. R takes Rch	24. K takes R
25. R to Ksq	25. R to KB5
26. P to B6	26. K to Q2
27. B to Bsq	27. R to B4
28. K to Kt3	28. K to K3
29. B to Kt2	29. P to QKt4
30. R to Qsq	30. B to K6
31. R to Q8	31. B to B5ch
32. K to Kt4	32. Resigns

KNOWLEDGE

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THE GREAT INDIAN EARTHQUAKE OF 1897.

By Charles Davison, sc.d., f.g.s.

(Concluded from page 150.)

Effects of the Earthquake.

Fissures.—Prominent among the earthquake effects are the fissures formed in alluvial plains. Mr. Oldham estimates that, where the necessary conditions prevail, fissures were fairly frequent over a region which measures about 400 miles from east to west, and about 350 miles from north to south, and present in smaller numbers over one nearly 600 miles in length from east to west. They were naturally more numerous near river-channels and reservoirs, on account of the absence of lateral support, and as a rule were parallel to the edge of the bank, a few hundred yards in length, and varying in width from a few inches to four or five feet.

Fissures in such positions are usually formed during every severe earthquake. But an interesting point established by the Indian earthquake is that they were also found in places far removed from any water-channel or excavation; sometimes running parallel to, and along either side of, a road or embankment; at other times skirting the foot of hills; but in every case clearly due to the compression of the alluvium during the passage of the earth-waves.

Many other evidences of the same compression were observed. Telegraph posts were displaced sometimes as much as ten or fifteen feet. In one part of the Assam-Bengal railway, the whole embankment, including borrow-pits and trees on either side, was shifted laterally through a distance of 6 ft. 9 ins. Rice fields in Northern Bengal, Lower Assam, etc., which had been carefully levelled so that they might be uniformly flooded, were thrown into gentle undulations, the crests of which were occasionally two or three feet above the hollows. The piers of bridges were moved alongside, as well as towards, the stream. Rails were bent over an unusually large area, the compression caused by the crumpling being always compensated by expansion elsewhere.

Sand-Vents, etc.—"Innumerable jets of water, like fountains playing, spouted up to heights varying from 18 inches to quite 3½ or 4 feet. Wherever this had occurred, the land was afterwards seen to occupy a sandy circle with a depression in its centre. These circles ranged from 2 to 6 and 8 feet in diameter, and were to be seen all over the country." This was at Dhubri, within the epicentral area. At Maimansingh, close to the south of the same area, these miniature craters seem to have been almost equally numerous, fifty-two being counted within an area 100 yards long and about 20 feet wide. In many districts, trunks of trees or lumps of coal and fossil resin were ejected with the water, and even, in one or two cases, pebbles of hard rock weighing as much as half-a-pound.

Over a large area, river-channels, tanks, wells, etc., were filled up, partly by the out-pouring of the sand, but chiefly by the forcing up of the bottoms. That the latter was the more effective cause is proved by the elevation of the central piers of many bridges crossing canals or streams. In this way, channels of from 15 to 20 feet in depth were obliterated, the bottoms being left level with the banks on either side.

Immediately after the earthquake, the surface of many rivers rose from two to ten feet, falling again to the normal level in the course of a few days.

Landslips.—Wherever the conditions were favourable, over an area not less than 300 miles in length, numerous landslips occurred. At Cherrapunji, which is within the epicentral area, there appeared to be more landslip than untouched hillside. Near the same district is a small valley, which, according to Mr. Oldham, was "an indescribable scene of desolation. Everywhere the hill-sides facing the valley have been stripped bare from crest to base. . . . At the bottom of the valley was a piled up heap of *débris* and broken trees, while the old stream course had been obliterated, and the stream could be seen flowing over a sandy bed, which must have been raised many feet above the level of the old watercourse."

Rotation of Pillars, etc.—At Chatak, which is close to the epicentral area, is an obelisk, built of broad flat bricks or tiles on a base 12 feet square and originally more than 60 feet high. This was split by the earthquake into four portions. The two upper pieces, about 6 and 9 feet long, were thrown down; while the third, 22 feet long, remains standing, but has been twisted through an angle of 30° with respect to the lowest part, which is unmoved.

Since the great Calabrian earthquake of 1783, this effect of a strong shock has been well known, and very many examples have been recorded. Its interest lies chiefly in the difficulty of finding a satisfactory explanation, or rather in deciding which of three or four possible explanations is the true one in any particular case. The numerous observations which Mr. Oldham has collected show that, during the Indian earthquake, neighbouring objects similarly placed were generally, but not always, twisted in the same direction; and he adopts the view, at which, however, he arrived independently, that rotation is chiefly due to changes in the direction of the shock. The detached part of the pillar, he believes, is tilted on one edge, and then, before it has ceased to rock, is twisted about that edge by later movements taking place in different directions.

Structure of the Epicentral District.

A large part of the epicentral district is situated in a group of hills lying to the south of the Brahmaputra valley, to which the name of the Assam Range has been given. "It is an elevated tract composed of crystalline gneissic and granitic rocks, with some metamorphic schists and quartzite, which carries a varying thickness of cretaceous and tertiary rocks along its southern edge." Mr. Oldham distinguishes three stages in the history of the range. There was first an old land-surface which, in course of time, was worn down by rain and rivers till they almost ceased to affect its form. Traces of this surface are still visible in the plateau character of the mass. It was then elevated, not uniformly, but along a series of faults, so that it consists now of a succession of ranges, the face of each range being a fault-scarp, and its crest the edge of an adjoining plateau sloping away from the summit. With this elevation began the third and last stage. The streams were able to work again, and deep gorges were carved out of the range, so far that in parts its original character is nearly effaced. But the retention of that character in other districts is of course evidence of the comparatively recent period of the final elevation.

Permanent Changes in the Epicentral Area.

Faults and fractures in the earth's crust are among the most remarkable of these disturbances. They are quite distinct from the fissures which occur in alluvial ground. The former are of deep-seated, the latter of superficial, origin; the one are connected with the causes of the earthquake, the other are merely its effects. The longest of these faults was traced by Mr. Oldham in the Chedrang valley (about 35 miles north-east of Tura) for a distance of twelve miles or more. Running in a nearly straight path from S.S.E. to N.N.W., the fault is crossed about a dozen times by the river, which at these points is either broken into waterfalls or ponded back by the vertical face of the fault. Pools of some extent are also formed by the blocking of the drainage in the western tributary valleys; for, wherever a change of level is perceptible, it is always the rock on the east side of the fault that has been elevated with respect to the other. The throw, or amount of elevation, varies considerably; the highest measured being 35 feet. In two places, it falls as low as zero; and here are formed broad sheets of water chiefly on the eastern side of the fault, and blocked, not by the fault-scarp itself, but by the undulation in the surface of the ground due to the increase of throw further down the valley.

Another fault-scarp, described by Mr. Oldham, is 2½ miles in length, with a maximum throw of 10 feet. There are also fractures along which the throw is either very small or imperceptible. The largest of these is the Bordwar fracture, about fifty miles east of the Chedrang fault. Near Bordwar, it crosses a low hill of gneiss, which it has rent in two. In the immediate neighbourhood of the fracture, the violence of the shock was extreme. Trees were overthrown or killed as they stood, and huge masses of rock were rolled down the slope. When the hill is left, the course of the fracture can be followed for a total length of about seven miles, being marked by landslips or by bands along which trees have been snapped across or overthrown.

While the crust was thus fractured without perceptible change of level, it was, in other places, thrown into long low folds which are apparently independent of faults. These are most easily detected when they cross the beds of rivers and are sufficient to reverse the direction of the drainage. There are then formed small lakes or pools, like the two which occur on the east side of the Chedrang fault. About 15 or 20 miles to the south of this fault, there is a group of such pools, a mile or more in length. The depth of the water increases gradually from both ends, until it reaches from 10 to 18 feet, and here may be seen trees and clumps of bamboos standing in the water and killed by the immersion of their roots.

There are, again, other facts which point to changes of level having taken place over a wide area. From Mao-phlang, near Shillong, a road leads to the neighbouring station of Mairang. Before the earthquake, only a short stretch of this road could be seen, where it rounded a spur at about three miles' distance. Now, a much longer stretch is visible, and it can also be seen passing round the next spur. From a road about five miles from the southern end of the Chedrang fault, it used to be only just possible to see the Brahmaputra over an intervening hill; now, the whole width of the river has come into view. At Tura, which is 95 miles west of Mao-phlang, a battalion of military police were accustomed to signal by heliograph with another station, Rowmari, 15 miles further to the west. This, formerly, could just be done by means of a ray which grazed a hill between the two places; it can now be done quite easily, and, in addition, a broad stretch of the plains east of the Brahmaputra is visible from the same spot. Thus, we see that the permanent changes have taken place over the northern part of the Assam Hills for a distance of about a hundred miles from east to west.

During the cold weather of 1897-1898, a revision of certain triangles was carried out by the Survey, but they were limited to the eastern part of the epicentral area, as the focus was at that time supposed to lie under the Khasi Hills. Of the 16 sides, only one was apparently unaltered in length, two were shortened by an inch or two, while the others were all lengthened by amounts varying from one to eight or nine feet. The heights of most of the stations were also found to be increased, one, close to a conspicuous fault-scarp, by as much as 24 feet. Unfortunately, all of these figures are rendered uncertain by the choice of the stations which form the extremities of the new base-line. One of them lies inside the epicentral area, and the other outside, the line joining them running nearly north and south. But, as compression in this direction is to be expected, it is probable that this line has been shortened, and the assumption that its length was unchanged would therefore lead to an apparent expansion of all the other sides. The only result of the re-survey is thus to place beyond doubt the fact that very important changes of some kind have taken place since the survey was first made in 1860.

Origin of the Earthquake.

The above facts all point to a complex origin of the earthquake. There may have been a number of completely separated foci, giving rise to a group of nearly concurrent shocks. Or, and this is a far more probable supposition, there may have been one great deep-seated focus, from which off-shoots ran up towards the surface.

As Mr. Oldham points out, we have recently become acquainted with a structure exactly corresponding to that which is here inferred. The great thrust-planes, so typically developed in the Scottish Highlands, are only reversed faults which are nearly horizontal instead of being highly inclined; but they are accompanied by a number of ordinary reversed faults running upwards to the surface. In Fig. 2, the main features

Fig. 2.—Diagram of Thrust-planes and Minor Thrusts.

of a section drawn by the Geological Survey of Scotland are reproduced; *TT* representing thrust-planes, and *tt* minor thrusts or faults. A great movement along one of the main thrust-planes could not occur without corresponding slips along many of the secondary planes. No direct effect of the former might be visible at the surface except in the horizontal displacements that would be rendered manifest by a trigonometrical survey; whereas the latter might or might not reach the surface, giving rise in the one case to fissures and faults, and in the other to local changes of level.

This, it should be remarked, is only a probable explanation. Others might be offered that would account equally well for some of the phenomena, but none, Mr. Oldham thinks, so completely for all the facts observed.

If the main part of the focus were continuous, as this theory would imply, its enormous dimensions will be evident from the facts that have been described. Mr. Oldham has traced the probable form of the epicentre. It may not be quite so simple or symmetrical as is represented by the continuous line in Fig. 1, but there are good reasons for thinking that it does not differ sensibly either in size or form from that laid down. The part of the thrust-plane over which movement took place must therefore have been about 200 miles long, not less than 50 miles wide, and between 6000 and 7000 square miles in area. With regard to its depth, we have no decisive knowledge. It may have been about five miles or less; it can hardly have been much greater.

It is a strain on the imagination to try to picture the displacement of so huge a mass. We may think, if we please, of a layer of rock, three or four miles in thickness and large enough to reach from Dover to Exeter in one direction, and from London to Brighton in the other, not slipping intermittently in different places, but giving way almost instantaneously throughout its whole extent; crushing all before it, both solid rock and earthy ground indifferently; and, whether by the sudden spring of the entire mass or by the jar of its hurtling fragments, shattering the strongest work of human hands as easily as the frailest. Such a blow might well be sensible over half a continent, and give rise to undulations, which, unseen and unfelt, might wend their way round the globe.

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor Alfred C. Haddon, M.A., Sc.D., F.R.S.

IV.—THE BEGINNING OF AGRICULTURE.

The origin of agriculture is lost in the mists of antiquity. We know that in Neolithic times in Europe, eight kinds of cereals were cultivated, besides flax, peas, poppies, apples, pears, bullace-plums, etc.; at the same time various animals were domesticated. Among these were horses, short-horned oxen, horned sheep, goats, two breeds of pigs, and dogs. Professor W. Boyd Dawkins says that evidence goes to show that these animals were not domesticated in Europe, but probably in the central plateau of Asia. He also thinks that agriculture arose in the south and east of Europe and spread gradually to the centre, north, and west. However this may have been, the growth of agriculture was in all likelihood slow, and some peoples do not take at all kindly to it.

We have already seen that a hunting population is often very averse to even the slight amount of work that agriculture requires in a tropical country. The same holds good, as a rule, for pastoral communities. In all cases a powerful constraint is necessary to force these peoples into uncongenial employment. Fate is stronger than will, and at various periods, in different climes, hunters and herders have been forced to till the soil.

In the New World there were no domestic animals in pre-Columbian times. Owing to the absence of the horse, the bison that roamed in countless numbers over the prairies could not be herded. On foot the intrepid Redskins tracked and slew with bow and arrow the big cattle they could not tame. When the horse arrived, the Redskins, or Amerinds (as our American colleagues now term them and all other autocthonous tribes), were too inveterate hunters to change their mode of life.

Over a considerable portion of America maize was cultivated from unknown antiquity, and other food plants and cotton were grown in suitable localities. It is doubtful whether the ancient civilizations of Mexico and Peru could have arisen had it not been for the cultivation of maize. Certainly they would have been impossible but for agriculture.

In the West Pacific, again, there are no domestic animals to speak of, no horses, cattle, sheep nor goats; the natives are fishers and hunters who have taken to a simple kind of agriculture, or it might more correctly, perhaps, be termed, horticulture, as no cereals are grown, not even rice, but only root crops such as yams, sweet potatoes, and taro; the banana is the only fruit tree that is cultivated in the true sense of the term, though the cocoanut, areca palm, bread-fruit, and a few other trees are grown. To take one example, the naked savages of Kiwai Island, at the mouth of the Fly River in British New Guinea, cultivate thirty-six varieties of bananas, twenty kinds of yams, and ten sorts of sweet potatoes, all of which have distinct names. Their only domestic animals are the pig and the dingo.

We have seen in the previous article how the deserts of Arabia and Sahara predispose the populations to commerce through the insufficiency of pasturage, and the organisation of the tribe educates the chiefs in the exercise of government.

The passage of these populations to a sedentary life is effected in the oases. These islands of vegetation in the desert are artificial. Created by man they disappear if not maintained by constant care. The creation of an oasis is a particularly difficult enterprise. In this burning climate, where rain is scarce, it is necessary to find a place containing a subterranean supply of water before the cultivation of the soil is possible. Thanks to the impermeability of the sub-soil, there are, below the arid wastes, distinct tracts along which water is always procurable. It is first necessary to bring the water to the surface and to direct it to the spots to be watered.

Sahara is not simply a great sea of sand, unsuitable for cultivation. In reality, over large areas the soil is composed of arable land of excellent quality, which solely requires moisture to make it very fruitful. Not only must the water be raised, but the watercourses must be protected against the invasion of the sand, which is a constant menace to agriculture. To undertake such difficult and complicated work, especially by herders who are but little inclined naturally to tedious and protracted labour, these people must have great interest in creating oases.

This interest is not far to seek. The deserts of Arabia and Sahara are not habitable without resting places for re-victualling. They are the countries of hunger and thirst, but in spite of all this man has had a prime interest in travelling through these deserts, for it is beyond them that the richest countries of the world lie—the tropical countries that produce perfumes, ivory, ebony, gold, precious stones, gum, and, above all, spices. It was to reach these fortunate regions that so many maritime expeditions were undertaken in the fifteenth and sixteenth centuries—voyages made famous by Vasco de Gama, Christopher Columbus, and all their glorious lineage of navigators. It was in seeking the country of spices by an eastern route that Vasco de Gama doubled the Cape of Good Hope, and discovered the direct route to Arabia and the Indies. It was in seeking the same country by a western route that Christopher Columbus discovered America. These different tropical products were of a character eminently suited for transport, as they were of great value and of small bulk, and the value was formerly many times greater than it is to-day.

The desert, notwithstanding all difficulties of communication, offered more facilities than the sea to early man; it had, in fact, three manifest advantages over the Mediterranean.

1. The desert penetrates further into the interior of the countries. It is several times larger than the Mediterranean, and therefore can tap more countries; it reaches to precisely those richest countries that the Mediterranean does not touch.

2. The desert does not oblige the pastor to seriously modify his mode of life. In order to traverse the desert it is certainly necessary to arrange the journey in stages, but these stages once created, the pastor can live his old life.

3. A numerous troop can cross the desert. They travel in caravans for greater safety and defence against possible attacks. Contrast this numerous troop with the smaller number who manned the ships of the Phœnicians and other primitive navigators of the Mediterranean, who in those early days had each evening to find a spot sufficiently sheltered to disembark; then they drew their ships ashore, often to find themselves exposed to the attacks of natives. Such are the reasons which caused early man to travel over the desert before voyaging over and utilising the sea. But this crossing of the desert was not possible, and is not possible to-day, without the establishment of resting places. Who could undertake the establishment of oases in a society of herders divided up into autonomous and often inimical tribes?

One can reply without hesitation. It was a group of men who, in the present and as far back in the past as records go, appeared always as the unique, uncontested, and omnipotent dominator and civilizer of the desert. This group does not belong to one tribe in particular, but it counts fanatical adherents among all tribes from one end of the desert to the other. It is the group that all conquerors who have tried to penetrate into the desert have found before them; the English as well as the French. These rulers of the desert are the religious fraternities or zanias; the members are called khuans, "brothers"; their chiefs khalifs, sheiks, etc. Sometimes, at certain epochs of inspiration or greater religious fervour, they are called Mahdi, "the well-guided." At these times woe betide those who attempt to penetrate into the desert. As the only point of contact between the different tribes was the community of the religious sentiment which is so highly developed among pastoral peoples, it was naturally the religious sentiment which became the shield and protection of the traders in the midst of hostile tribes. As the profits of commerce brought considerable benefits, these brotherly protectors of trade developed extremely rapidly and accumulated enormous riches. None can safely traverse the desert without placing themselves under their protection.

One can better understand this influence if one remembers that in the Middle Ages commerce found a safeguard, support, and an auxiliary in the military religious orders, a fact due to the influence of analogous causes. Then, as in the desert, there was no central government, only a multiplicity of petty rulers with limited authority, who could not give general protection to commerce. The military religious orders naturally hastened to take up the *rôle* of protectors of commerce. One knows that the Templars, for example, practised it themselves, that they were the great bankers of that time, and that they thus acquired immense riches. And they declined precisely when the great political governments developed in the west and became able to protect commerce from afar. But the desert being by its nature unchangeable, the religious brotherhoods continue to this day.

The oases serve the double object of places for re-victualling and *depôts* for merchandise. To re-victual caravans and also to feed its inhabitants it is necessary to draw from the soil the greatest amount of food within the restricted areas. The only vegetable that accommodates itself completely to the special conditions of soil and climate is the date palm. Its fruit is truly the bread of the desert; with camel's milk it forms the staple food. Dates present great advantages to desert travellers. They are easy to preserve by desiccation and easy to carry, as pressed into bags they contain a large amount of nourishment in a small bulk. Each tree furnishes about 26 lbs. of dates in a year.

But the palms yield other products; the crushed date stones supply food for goats and even camels; the fibre, leaves, and trunk, are all utilized for various purposes. Thanks to the grateful shade they spread, the effects of the tropical heat and burning sun are lessened. There is cultivated under their shade a number of plants which very usefully supplement the direct gifts of the palm. Thus the oases produce beans, cabbages, carrots, melons, tomatoes, egg-plants, apricots, peaches, apples, quinces, etc. Plants that require heat and light with us demand the coolness and shade that the palm tree affords.

The oases are the *dépôts* of merchandise, and are the chief market centres of the desert, whose riches naturally excite envy and must be protected: thus the oases are fortified.

The oasis modifies the social organization in three essential matters:—

1. Work becomes sedentary, but trade and commerce predominate over agriculture. The complication due to a fixed home is reduced to a minimum, for the men of the oases continue to live a nomadic life for at least part of the year. It is these men who effect transport and who trade either for themselves or others. Besides, the actual cultivation of the oases is relatively easy, it is almost spontaneous, as the chief products are from palm and fruit trees; it is arboriculture, which is the easiest of all. The growing of vegetables does not need any great foresight, for the period of growth is so short; the work they need is soon repaid by the product. Further, the men mainly avoid doing this work. It is relegated to women and to negro slaves, who also form an important article of commerce. Thus this cultivation has not the result of reducing the men to work hard at husbandry. Count Goblet d'Alviella writes:—"Every year a certain number of Suafos emigrate into the towns of Tunis and Tell, where they live in the Moors' quarters as blacksmiths, masons, clerks, etc.; but, like the Swiss and Savoyards, they have a great attachment to their native land, and nearly always return thither when their fortunes are made. They then marry several wives, whom they employ to weave. They buy negroes, and thus realise, in pious idleness, the Musulman's ideal life."

2. The condition of women is raised. She has the sole charge of the workshop during the long absence of her husband; she watches over the gardens and flocks, which feed around the oasis, and she makes various domestic fabrics. She thus acquires a position of mistress of the house, and is as much, and often more than the husband, the source of income to the household.

3. Government is constituted outside the community of the family. How could government be constituted outside the family in the societies which we have seen are so strictly limited to the family and the tribe which is, after all, only an enlarged family?

Who could organise government except the religious brotherhoods who have created the oases? The administration of the oases is in the hands of the khuans and zanias, who reign as masters. In the larger oases all the religious orders are represented, their wealth is enormous, but their organisation is very simple. The members of the order are composed of khuans ("brothers") and mokaddems and sheiks. The khuans are the mass of the initiates. By mokaddem is meant the direct representative of the sheik, who receives alms, presides over religious ceremonies, and directs the consciences of the khuans. The sheik is the supérieur général or grand master of the order. He resides in or near the tomb of the holy founder of their order, and gives the baraka or benediction. Often below the initiated khuans there are khoddams, servants or clients, who do not receive the special prayer of the order. They are generally entire tribes who adopt the policy of the order and act as defenders. The fraternities hold in their hands the administration of the oasis. This is summed up in the djemâa assembly of notables, chosen by each of the quarters of the oasis from the ranks of the khuans.

Dependent upon the djemâa are six functionaries chosen from the dominant religious party. One is a sort of police agent; he guards the gates, signals the approach of an enemy by beating a drum, is the chief of scouts, and receives travellers and appoints them to various houses. The second unites the functions of the public crier and the clerk of the works. The third is the distributor of water—a very important trust. These three are paid in kind. The three following officials hold purely religious posts. The steward of the mosque is an honorary appointment. The marabout, who has charge of the services, recites the daily prayers, presides at all ceremonies and funerals, and teaches in the school, is lodged and paid. Finally, the muddin, five times a day mounts the minaret of the mosque to cry the prayer of Islam.

Naturally these brotherhoods quarrel for supremacy, often long and cruel wars result. At the present time one of these orders is pre-eminent, it is the famous order of Snussia. The Snussias cleverly tried to constitute a vast federation of all the religious orders, to create a theocratic panislamism, exclusive of all secular authority. To render this federation more acceptable they have reduced to a minimum their religious formulas and the duties imposed on the khuans. This order is recent, being founded about 1835, by Si-Mohammed-ben-Ali-ben-Snussi. After many vicissitudes he founded a zania at Djerboub, in Tripoli, and since then more than 250 in Sahara and Arabia; all are directed from Djerboub, the headquarters of the order.

On the northern borders of the Sahara are more or less cultivated lands, which are termed by Demolins "half oases," who states they are largely peopled by fugitives from the desert—that is, by people who, in every epoch, have been evicted from it; speaking generally, they have not gone of their own accord, for these men, little accustomed to work, prefer the adventurous life of the desert to the narrow life of its confines. They bring with them, however, their aptitude for business and their skill in organising government, which become still more accentuated under the new conditions. These border countries are often not favourable to agriculture. Many are mountainous and have poor soil; but they are favourable for barter, lying as they do between two great commercial highways, the sea and the desert. The inhabitants therefore take to commerce. In these border states agriculture is undertaken by the least capable and enterprising; the others give up agriculture on the first opportunity and take to small manufactures or to commerce.

The various Kabyle tribes have each their speciality, and as they hold markets in each village on successive days the inhabitants can procure all they require. Many women make beautiful pots. Weaving occupies some tribes, wood-carving others, some are clever blacksmiths. One has learned from a French deserter how to make guns. Jewellery and smelting constitute the industry of one group. Their markets are busy, and are used also as general assemblies for the discussion of public business. The emigrants from the villages carry on different trades. Some become bakers, others bankers to their fellow countrymen in the different villages, most become pedlars. They are in no great hurry to accomplish the pilgrimage to Mecca, and when they do go, they travel more as merchants than as pilgrims.

Here on the border countries the influence of the religious brotherhoods persists, but the organisation of government is freer and more spontaneous. There is less need to submit so completely to the interference of the brotherhoods. The chiefs of the families are apt to set going the machinery of political life by themselves, and they emancipate themselves from the tutorship of the religious orders. Thus the authority of purely religious powers tends to diminish while that of the family chiefs increases. Reclus states:—"They respect the marabouts; at the same time they are suspicious of them, and take care not to let them infringe on the rights of the community. They assign to them special villages situated apart from the tribal villages, and therefore liberty is not likely to be endangered." What a change for these men who opened up and organised the desert and who still govern it!

Each village forms "a small republic governing itself." All the citizens form part of it; as soon as they carry arms they have the right of voting. The Djemâa meets once a week and decides all questions. One can therefore say that in the desert borders power passes from the religious to the lay form of government; but in its new form this power continues to follow the same tendency that invariably inspires the communitary formation, which encroaches upon and in its very nature tends to restrain the initiative of the individual in private life. But here the state increases, since, owing to the sedentary mode of life, the community of the family is both restricted and enfeebled and opposes a decreasing resistance to the action of an external government.

In my next article I propose to deal with other communities having a similar origin from pastoral peoples who have also been constrained to till the soil.

ASTRONOMY WITHOUT A TELESCOPE.

By E. Walter Maunder, F.R.A.S.

VII.—METEORS;—THE PERSEIDS.

Of all the subjects for study open to the astronomer who has no optical assistance at his command, none can be so easily or so frequently observed, none afford him such an opportunity for really useful work, as do meteors. And though meteors may be observed practically the whole year round, except when cloud or moonlight interferes, yet one month ranks pre-eminently as the meteor month—the month of August.

This is due to the occurrence then of the well-known periodic shower of the Perseids; the "Tears of St. Lawrence."

It is very striking in looking back into astronomical records to note how very recent is most of our information concerning meteors. For thousands of years men have been aware that there were "wandering stars to whom was reserved the blackness of darkness for ever." At times, too, they would come, "not single spies but in battalions," in such numbers and with such brightness as to compel attention and create the deepest astonishment and fear. But for all those ages it does not seem to have occurred to anyone to try and *observe* them; that is to say, to record such facts about them as it was possible to ascertain during the brief moments that they shone.

There is an immense gulf between the mere admiration of the phenomena of nature and their observation. The first is utterly unfruitful; long generations of men pass, each having seen the same kind of event, and yet the accumulated experience of ages leads to nothing. But, on the other hand, let one man, or, better, let three or four give a few years to the careful, steady record of everything that they can ascertain about some phenomenon, however unpromising, and what marvellous facts leap into light!

How utterly ignorant even recognized authorities were but sixty years ago may be seen from the following quotation from a standard text-book bearing the date 1840.

"The Falling Stars, and other fiery meteors, which are frequently seen at a considerable height in the atmosphere, and which have received different names according to the variety of their figure and size, arise from the fermentation of the effluvia of acid and alkaline bodies, which float in the atmosphere. When the more subtile parts of the effluvia are burnt away, the viscous and earthy parts became too heavy for the air to support, and by their gravity fall to the earth.

"On the 13th of November, in the year 1833, a shower of meteors fell between lon. 61° in the Atlantic Ocean, and lon. 100° in Central Mexico, and from the North American Lakes to the southern side of Jamaica. These fireballs were of enormous size; one appeared larger than the full moon at rising. They all seemed to emanate from the same point, and were not accompanied by any particular sound. It was not found that any substance reached the ground so as to leave a residuum from the meteors."

It did not seem to occur to the writer of the above description that the circumstance which he mentions—namely, that the meteors "all seemed to emanate from the same point," itself proved that the meteors were entering the atmosphere from outside and were moving along parallel lines at the time of their entry.

The great display referred to above, however, was the foundation of modern meteoric astronomy. So magnificent a spectacle as was then witnessed not only attracted thousands of gazers, it caught the attention of men who were resolved to use every possible opportunity for learning.

The enormous numbers of meteors seen in the November shower of 1833 rendered it manifest that on that occasion, at any rate, the falling stars seemed to have their origin in a single point of the heavens, and therefore it became an important point whenever a meteor was seen to note exactly the direction of its flight. Humboldt, who had himself seen the great November shower of 1799, writing in 1844, recognized four points in the heavens from which meteors seemed to fall, and drew attention, though with some hesitation, to the reasons for thinking that the November shower was only occasionally to be seen in great force. Sir John Herschel, about the same time, recognised only two showers, those of August (the Perseids) and those of November (the Leonids). Now by the labours of a very few observers, one of whom, Mr. Denning, may be said to have outweighed all others put together in the value and number of his results, we know of many hundreds of radiant points, whilst the researches of Adams and Schiaparelli have enabled us in some cases to trace the meteor streams in their path, not only far beyond the spread of our own atmosphere but to the very limits of the solar system, and they have been shown to be not mere distempers of the air, but bodies of a truly planetary nature, travelling round the sun in orbits as defined as that of the earth itself.

How has this great advance been made? Simply by careful, patient, intelligent, observation. First of all by carefully noting the points in the sky where the meteor was first seen and where it disappeared. This requires a thorough knowledge of the constellations, as indeed all naked eye astronomy does, and great quickness of observation. The meteor worker must be able to give the two extremities of the path at a glance and to remember them faithfully until he can in some way or other note them down.

For this he will require a certain amount of what we may term apparatus, either a celestial globe or a set of star charts. The choice of the latter is of importance, as no possible chart can show the entire sky without grave distortion some way or other, and more important for the present purpose there is only one projection which will give a straight line on the chart for all great circles or parts of them; that is to say, for all lines which impress us as straight lines as we see them on the sky.

The observer's first duty, therefore, is to acquaint himself with the constellations; his next, by repeated and persistent effort, to learn quickness and correctness in fixing the extreme points of the meteor paths. This done, he will recognise that there are several other features in which meteors appear to differ, the one from the other. His observations of the paths will soon show him that the length of a meteor path varies greatly; he cannot fail further to notice that the apparent speed with which it travels varies also. To the record of the path, therefore, should be added the determination of its length, which of course can be read off from the globe after the track has been marked down upon it, and the time which the meteor took to traverse it. And as for comparison with the records of other observers it is essential to know when the meteor was seen, this should also be noted as well as the duration. Indeed, as a matter of order, the date and time of the occurrence should come first; then the position of the beginning of the path; third, the position of the end; fourth and fifth, the length of the path and the time which the meteor took to traverse it.

The actual meteors themselves also have their individual characteristics. Some leave phosphorescent streaks behind them, others trains of sparks. More striking than anything else is the enormous difference in brightness, from one like the meteor alluded to above "larger than the full moon at rising," down to others only just visible to the naked eye. These particulars as to character and brightness will be the sixth and seventh items to note, and when a number have been observed sufficient to give an indication of the radiant, this should be added as an eighth.

Steady persistent practice in noting these particulars will soon give the observer increased skill. One item requires especial attention—the duration of the meteor. Mr. Denning tells us that he has trained himself by observing the flight of arrows. He has employed a friend to shoot these to distances from fifty to two hundred yards at right angles to the line of sight, the elevation being varied as much as possible, and that by repeating these experiments he has learned to judge intervals of from one to five seconds with an average error of less than one-fifth second.

All the above particulars and not merely the direction of the paths alone are of value in the determination of the radiant point. The meteors of one radiant have similar characters as to colour, streaks, etc., and also as to speed of course. The apparent length of path is affected by the height of the radiant point, Mr. Denning noting of the Perseids of August 10 that, whilst between 9 and 10 o'clock in the evening the brighter meteors average a course of about 30°, in the morning hours when the radiant is near the meridian their paths are only one-third the length.

As in all good work, skill is not acquired at once, and the would-be meteor observer will find that he makes many failures to begin with. His first successes will probably be with some bright slow-moving meteor, and as these are relatively few, he will probably have to wait a very considerable time before he can accomplish much. This need of patience and practice is one great reason no doubt why so few take up a pursuit which requires no equipment and which soon becomes full of fascination. Another is to be found in the unfortunate fact that from midnight to dawn is a much more fruitful time than from sunset to midnight, since the meteors which come to meet the earth are necessarily much more numerous than those that overtake it, and the earth has its sunrise point in front as it moves forward in its orbit, its sunset point behind.

Yet there are always prizes to be secured. There is a great pleasure when some brilliant wanderer flashes by in knowing that one has secured as full and accurate a record as possible of its appearance. It was seen but for a moment,

> "Like a snowflake on the river,
> One moment white, then gone for ever."

Yet it has left something behind, something permanent, something which years after may be eloquent of unsuspected truth.

The great Perseid shower, chief of all those which are of regular annual recurrence, has been rich in such indication. It has shown itself to be in intimate connection with the Third Comet of 1862 discovered by Swift. It has been traced night after night for a very considerable time before the date of its maximum, August 10, the radiant point travelling steadily backward in the sky from the borders of Cassiopeia and Andromeda in the middle of July to those of Camelopardus in the middle of August; the steady shift of the radiant, night after night, having been abundantly demonstrated by observations as well as being in strict accordance with theory.

In sharp contrast with the shifting of the Perseid radiant has been another fact which long years of patient work has enabled Mr. Denning to demonstrate—namely, the existence of radiants which do not shift, radiants which endure for many months together. Here was a circumstance which could not have been anticipated, which was indeed in flagrant contradiction to the theory of meteoric motion, and which even yet remains without any adequate explanation. Yet one single observer, by sheer patience and perseverance, has driven home the unexpected, unexplained, seemingly impossible fact, and after having been long rejected even by experts, the fact of stationary radiants has at length received general recognition.

Such a fact, unexampled in the history of astronomy, ought to make many a meteor hunter. For six thousand years men stared at meteors and learnt nothing, for sixty years they have studied them and learnt much, and half of what we know has been taught us in half that time by the efforts of a single observer.

[The illustration on page 158 (July) should have been lettered "The Milky Way in Cygnus; from M. C. Easton's 'La Voie Lactée.'"]

THE TOTAL SOLAR ECLIPSE OF 1900, MAY 28

(Second Paper.)

By E. Walter Maunder, F.R.A.S.

The Eclipse of 1900 has been so very prolific of result that, even at this early date, to adequately notice everything that has come to hand would require a long series of articles. I propose, therefore, on the present occasion simply to catalogue the results which seem to me to be of most importance.

1. Large Scale Photographs.—By large scale photographs I mean photographs giving a diameter of four inches or more to the moon's disc. These are becoming more and more a regular feature of eclipse work, and on the present occasion both the Astronomer-Royal and the Astronomer-Royal for Scotland from this country undertook this department with great success. The instruments were of very different types. The Astronomer-Royal's camera possessed an object glass of 9 inches aperture and only $8\frac{1}{2}$ feet focal length, a four inch image being obtained by a negative combination within the primary focus; the camera was fixed and fed by a cœlostat. Dr. Copeland's instrument was the 40 foot focus lens which he took to Norway and to India. This was not pointed direct to the sun, as at Vadsö in 1896, but the light was reflected into it by a fixed mirror, and the plate was made to travel instead of the telescope. This ample scale has been exceeded by the American astronomers, who have used object glasses of $61\frac{1}{2}$ and 133 feet focus, securing photographs on scales of seven and fifteen inches to the lunar disc.

Without dwelling at length upon the beautiful detail both of corona and prominences shown on the Astronomer-Royal's photographs, a comparison of his Indian and Portuguese negatives teaches a very significant lesson. Valuable as each series is in itself, it is not too much to say that each has a double value in its comparison with the other. It is most earnestly to be hoped that no slight difficulty will be allowed to prevent a series so magnificently begun being continued, eclipse after eclipse, with the same instrument and on the same scale. The closing in towards the equator of the great extensions, the diminution of structure in the lower corona, the greater separation of the polar plumes, and the greater amount of general diffused, amorphous coronal light, as seen in the Eclipse of 1900 when compared with that of 1898, is most evident. This year's

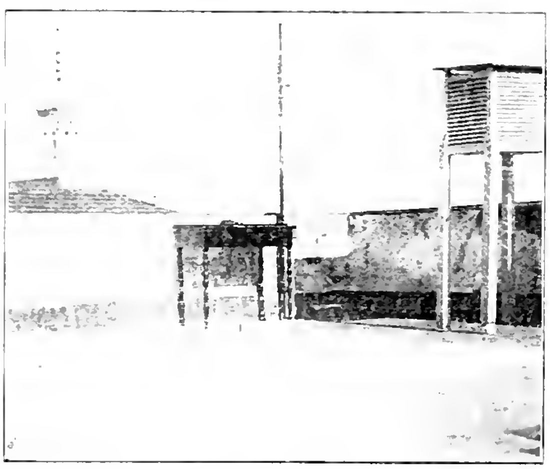


Fig. 1.—The Meteorological Instruments and Shadow-Band Sheet, Hotel de la Régence, Algiers.

From a Photo by Miss Edith M[illegible].

eclipse was emphatically an eclipse of the sun-spot minimum; it reproduced the general form,—it is scarcely an exaggeration to say, even the detail,—of the Eclipses of 1878 and 1889 at the two preceding minima with astonishing fidelity.

2. Medium Scale Photographs; that is to say, of a scale of half-an-inch to two inches. These were too numerous to catalogue, but here we must express a regret. For a long series of years the British official expeditions have taken photographs with identical lenses of about 5 feet focus. It is a pity that the series has this year been brought to a close or at least interrupted.

3. Small Scale Photographs; that is to say, less than half-an-inch in diameter. A large number of these were no doubt taken with fixed cameras in consequence of our having pointed out that for most purposes there was no need to use a driving clock with short focus lenses. But several were taken directly in consequence of the success in their delineation of the coronal extensions of our long exposure photographs in India. The result of these so far as we have yet heard has been to show distinctly that it was not possible *in this eclipse* to photograph the streamers to the same extent as in 1898, but, on the other hand, quite a short exposure proved practically as effective as the most lengthy given, in bringing them up. Still the character of the extensions was the same; the typical coronal curves running as in 1898 into rod-like rays.

Before leaving the photographs of the corona, it may be worth while to mention a mistake into which apparently more than one photographer has fallen, that of driving on the moon instead of on the sun. A stationary camera will give a blurring of 15″ of arc for an exposure of one second of time; one made to follow the moon gives a blurring of $\frac{1}{2}$″ in arc for an exposure of the same time, and *vice versa* if it follows the sun, the blurring of the moon's limb in the direction of motion will be of the same amount in the maximum. An exposure therefore of $\frac{3}{4}$ of a minute would mean a blurring of considerably more than a third of a minute of arc. This would mean 1/100 inch for an inch sun, or a millimetre for one of 4 inches. These are very considerable amounts, hence a long exposure photograph cannot be given so as to ensure sharpness both of moon and of corona. A sharp moon under such circumstances means a blurred corona.

4. Integrating Photographs.—Several Members of the British Astronomical Association, myself amongst the number, devised a method for exposing photographic plates to the general light of the corona in 1896. The unfortunate weather on that occasion prevented the scheme being carried out, but Mr. Gare and Mr. A. H. Johnston arranged a careful scheme in 1898, the execution of which was successfully carried out by Mr. E. W. Johnson. The same observers repeated their experiments at Manzanares and Elche in Spain this year, and they have had a follower in Professor H. H. Turner, who carried out a similar work at Algiers. Professor Turner's result shows this eclipse to have been very considerably brighter than the Indian; Mr. Gare finding the corona seven times as bright as the moon in 1898, Professor Turner putting it at ten times the moon in 1900.

5. Standardized Photographs.—Most, if not all of the photographs of the corona obtained by the British official observers have been "standardized" by the imprinting upon the plates of a series of squares representing known light values. This practice gives to the photographs an entirely new importance over and above the value they possess as pictures, and it is much to be wished that the practice were more general with independent observers. The work of measuring and reducing the photographs of the late eclipse can scarcely have proceeded very far as yet, and no results in this line have yet appeared from them; but similar results from

the 1898 Eclipse, now two years and a half old, should by this time be in a very complete state of discussion. It is much to be regretted that a little more speed was not made so that they might have been in the hands of astronomers before their starting for the late eclipse.

6. Polariscopic Photographs.—To Professor Turner in 1898 we owe the revival, as an item of eclipse programmes, of the taking of polariscopic photographs of the corona, most successfully carried out by, and under the direction of, Professor A. W. Wright in 1878. This work Professor Turner, in conjunction with Mr. Newall, renewed in the late eclipse, and it is to be hoped the success they attained will prevent it being again dropped, for it is to be borne in mind that at present we have only polariscopic photographs from minimum coronæ, and it is a matter of great importance to ascertain whether the intensity and distribution of the polarization vary at different parts of the sun-spot cycle.

7. Spectroscopic Observations.—Photographs of the spectrum formed a most important feature of the programme of all the official parties. Mr. Dyson at Ovar had two large slit spectroscopes; Sir Norman Lockyer at Santa Pola had a prismatic camera of 20 feet focus; Dr. Copeland used a prism in front of his lens of 40 feet focus during part of the eclipse; Mr. Newall at Bou Zaréa photographed the "flash" with a slit spectroscope; Mr. Evershed at Mazafram, as recently mentioned, had two prismatic cameras, one of them being a reflector. All appear to have been most successful in their work, but many months will necessarily elapse before the photographs obtained will be measured, reduced, and published. It may be mentioned, however, that Mr. Evershed's reflector photographs give the lines with unexampled sharpness of definition from end to end, and that Dr. Copeland claims to have secured the spectrum in the ultra-violet so far as wave-length 3000.

Amongst the independent observers it should be mentioned that Dr. Downing, observing with an opera-glass fitted by Mr. Thorp with a prismatic grating before the object glass, found the combination work most admirably. The special subject of his scrutiny was the diffusion of "coronium" as evidenced by the shape of the green coronal ring. This averaged about 100,000 miles in height, but in one particular region it rose to a height of 180,000.

8. Shadow-Band Observations.—These appear to have been made with special fulness and care at several different stations. The results of these observations have not yet been collected, but it may be mentioned that Mrs. Arthur Brook, whose apparatus is shown in the photograph, observing at Algiers noted the "bands" rather as separate patches closely following each other in long wavering ranks. Mrs. Brook made observations of a unique character on the "shadows" near the time of third contact when Baily's Beads began to appear, and she asserts that the "shadow patches" were then of a materially different character from what they were a few seconds later still, when the sun itself emerged and the light was stronger. As in India there is a marked divergence of opinion at different stations as to their directions of motion before and after totality. At Algiers Mr. Brook says decidedly that the direction before second contact was approximately the same as after third contact. At Elche the observers say that the second direction of motion was reversed.

9. Naked Eye Drawings of the Corona.—Of these the late eclipse has yielded an unprecedentedly large supply, of the average quality of which it is scarcely possible to speak too highly. It is a curious and unexpected detail of evolution that not only is there a progress in artistic ability and truth in the individual through the means of his personal practice, but there is also in the race. The same sort of thing has been noticed before now in drawings of the surfaces of the moon and planets. Men see more easily and depict more faithfully, faint, difficult or minute markings, than was done fifty or a hundred years ago. Indeed the trend towards uniformity has been so strong as occasionally to draw forth sharp criticism, and hints of the effect of bias. That could not be the case here; drawings made by observers separated from each other by scores or hundreds of miles and having not the slightest means of communicating with each other have by their resemblance borne the most striking testimony to the skill

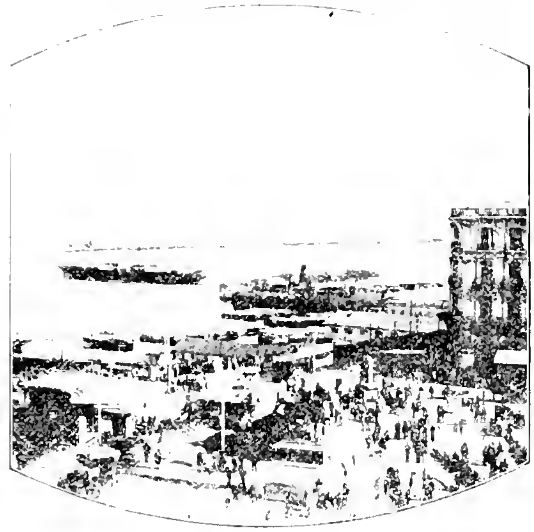


Fig. 2.—The Harbour, Algiers, five minutes before Totality.
From a Photo by Miss Edith Maunder.

and fidelity of the artists. There has been a complete absence of the grotesque and extravagant designs that were common enough a generation ago. Some of the drawings too were made with the most astonishing rapidity, Miss Stevens', for example, already reproduced, was the result of less than forty seconds devoted to the scrutiny of the corona, and yet,—though not intended to exhibit in particularity the details of the corona,—it could be scarcely surpassed as a representation of the general effect. This improvement is a matter for the greater congratulation since it is manifestly due to greater skill in the observer, and the observer must always be more important than the instrument. The improvement in the delineation of planetary surfaces might well have been ascribed to the improvement of telescopes, but that cause cannot enter in the case of drawings of the corona made with the naked eye.

10. Drawings with the Telescope.—This work has been to a very great extent the special feature of the late eclipse. In particular it is a subject for congratulation that Mr. Wesley, whose skill as an artist is so well known, and whose acquaintanceship with coronal forms as shown on photographs is unapproached, was by the most generous courtesy of M. Trépied put in possession of the equatorial coudé of the Algiers Observatory on the occasion of the eclipse. "I think," said Mr. Wesley, "I have had the most magnificent—though restricted—view of the corona that ever mortal man had—something to have lived for." Mr. Wesley made a study of and sketched the entire corona within his field of view, which

did not of course include the outer streamers. His first impression was that of the entire familiarity of the object he beheld; the photographs of 1878 and 1889 had so exactly presented the same leading features. The great difference was that in looking at the reality and not at the photographic picture a sense of perspective and of relief was perceived, whereas the photographs seemed essentially plane sections. In one sense the sight was disappointing; there was no structure seen more detailed than the microscopic scrutiny of photographs had already made Mr. Wesley familiar with. Probably no one else knows how much the photographs really have to show. However both the photographs and direct examination concur that the corona at this eclipse showed much less structure than in 1898 and other years nearer the solar maximum.

One form in particular Mr. Wesley looked for. Round the more brilliant prominences of 1893, the corona was perceptibly fainter for some little distance; a brighter margin including the prominence region some way further out. The prominences therefore seemed to be arched over by bright coronal matter, giving somewhat the effect as if they were under glass cases. Mr. Wesley could not, however, recognize this "glass case" appearance, nor do the photographs clearly show it.

This last conclusion is more than confirmed by the detailed examination made by Miss Lilian Martin-Leake with a three inch telescope mounted on the roof of the Hotel de la Régence, Algiers. Miss Martin-Leake used a higher power than Mr. Wesley, and hence had a smaller field of view, only commanding a part of the corona but giving this with more detail. The portion of the limb examined by Miss Martin-Leake, whose drawing is reproduced in the plate, had for its centre the great prominence in the south-west quadrant. It will be seen from the drawing that the chief coronal streamer in the region under examination had its polar edge very sharply defined;—nothing further to the south, of a coronal character, could be perceived within the field of view; a circumstance to which we shall have to allude again a little later.

Round the great prominence itself there was an approximation, indeed, to the "glass case" effect, but with a difference. Instead of inclosing the prominence, two of the "glass cases" appeared to start from between the two wings of the prominence. The taller of these wings was a conical flame, red in colour, proceeding straight upwards from the limb, tapering to a fine point at its apex and showing strongly defined spiral markings throughout the whole of its upward course. The other part of the prominence consisted of a thick radial stem also with strongly defined spiral markings, but about three quarters of the height of the taller prominence from the limb, the second one bent sharply, almost at right angles, towards it.

The same region was also examined in the telescope, but only for a few seconds, by Mr. Crommelin, who drew three conical projections corresponding most closely to those brighter portions of the corona inclosed within the outlines which Miss Martin-Leake has shown.

11. Dark Rays in the Corona.—I may be forgiven for again reverting here to the fact that my wife and I had but a very small instrumental equipment both in the eclipse of 1898 and in that of 1900. We felt therefore that it would be quite absurd for us to attempt to do on a microscopic scale what was being done by others in an infinitely more satisfactory manner, namely, to get a photographic picture of the corona. If our work was to have any value at all it must be something different from that which others were doing far more efficiently than we could hope to do. In India, therefore, we set ourselves a two-fold task; the first to give a series of exposures to the corona varying over a far wider range than any that had been attempted before; the next to get, if possible, a photograph of the faint outer streamers of the corona. Both attempts were successful, but inasmuch as our longest Indian exposures were the most successful in bringing up the rays, it left it an open question whether a still further prolongation of the exposure might not record those rays to a still greater distance from the sun. In the eclipse just past, therefore, we prolonged our exposures to the utmost extent which the circumstances of the eclipse permitted, with the result of finding that for this eclipse, at any rate, increase of exposure did not mean increase of extension.

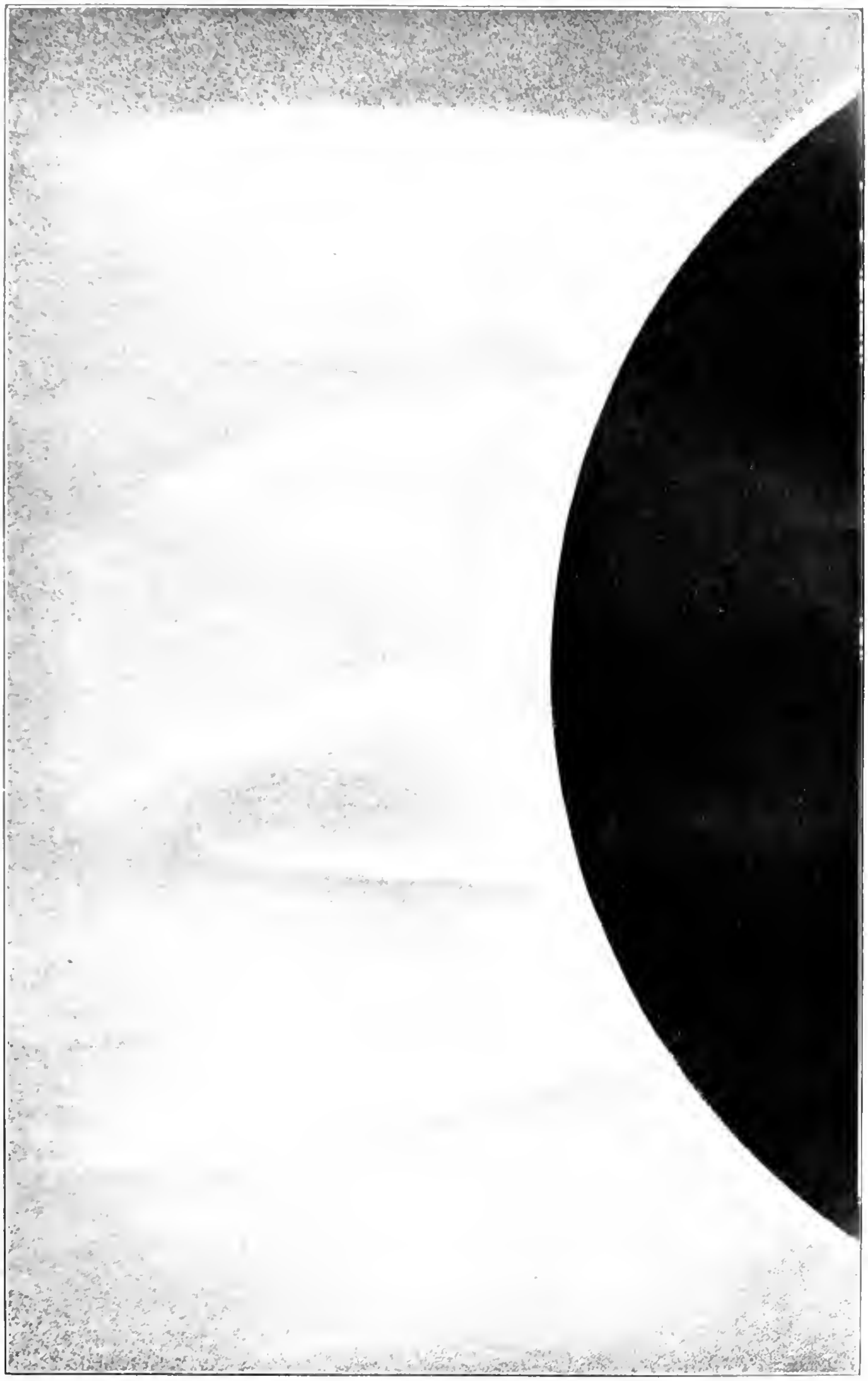
But these little long-exposure photographs of ours do show features which are not shown, or, at any rate, not shown so distinctly on our photographs of shorter exposure. Of deliberate purpose we pushed exposure and development to the furthest limit that the circumstances of the case allowed. Our object was not to get a photographic picture of the corona; we knew that was being far better done elsewhere. Had we been trying for such, then both our exposure and development would have to be censured as extravagant. As it was, we obtained a most unexpected result that could probably have not been obtained in any other way.

It will have struck anyone who has examined eclipse negatives that upon these the moon very frequently comes out much darker than the sky even at a great distance from the sun. This is a very remarkable circumstance, for we must remember that in an eclipse the moon is more fully illuminated by "earth-shine" than on other occasions. The moon therefore is not black or anything like it in a total eclipse, and if it appears much darker than the sky, it can only be because there is a very appreciable amount of diffused light round the sun itself perfectly distinct from any scattering in our own atmosphere.

This consideration gives its significance to a very curious feature of our little photographs, namely, some *black rays;* rays, that is to say, distinctly darker than the general sky background, or rather what I may call the general coronal glare. The largest and darkest of these rays, it may be added, is that shown on the edge of Miss Martin-Leake's drawing as a region free from coronal light.

These dark rays are not a mere contrast effect, for though undoubtedly the northern edge of the principal one corresponds to the southern edge of the great south-western streamer, yet it is traced as a distinct black line further than the bright coronal ray on the border of which it lies, nor is there any very manifest bright ray to define the other, that is to say, the southern side of the dark ray. These dark rays therefore can only be seen as such where the exposure and development have been sufficient to bring up the general coronal glare.

The matter is one of great importance as it regards our conception of coronal structure. The explanation of the great rifts which have often caught attention both in the corona itself when observed directly and in photographs of it, has been extremely difficult, on the assumption that they are the mere interspaces between the bright streamers, since it is inconceivable that the corona is really what it appears to be, an object in two dimensions only. I think our photographs, though on so small a scale, afford evidence that in some cases at



THE CORONA OF 1900, MAY 28 (S.W. QUADRANT).

From a Drawing by Miss Lilian Martin-Leake, with a 3 inch Refractor, at the Hotel de la Regence, Algiers.

least the coronal rifts are neither contrast effects nor mere interspaces between bright rays, but are caused by the interposition of actual dark absorbing matter between ourselves and the general diffused coronal glow. The form of the corona, as it appears to us, is therefore not wholly an emission, but partly an absorption effect.

SOME EARLY THEORIES ON FERMENTATION.—II.

By W. Stanley Smith, ph.d.

(*Concluded from page* 155.)

Van Leeuwenhock, 1632—1723, was the first to behold the beautiful cells of the yeast plant, *Saccharomyces*, and he it is who first records their morphology. It is, however, all too certain that Van Leeuwenhock passed away unconscious that his cells were endowed with life; they were to him "globulis nempe ex quibus farina," mere globules of starchy nature derived from the cereals, wherewith the early brewer prepared his wort. More than a century and a half must perforce roll by ere Caignard de la Tour, in France, and Schwann, in Germany, could proclaim the vital nature of our yeast. The former man of science, observing that it lacked the power of motion, dubbed yeast a plant, and proclaimed this plant to be the first cause of alcoholic fermentation. Schwann, on the other hand, arrived at the same conclusions, only by a very different method of reasoning. He believed that only mineral poisons were fatal to plant-life, whereas animals succumbed to both mineral and vegetable toxicants. He found his yeast-plant unharmed by strychnine, whilst it succumbed to the presence of arsenic. In order to illustrate the veritable depth of learning achieved by Schwann, we must quote some few of his words. "It is impossible," says he, "to mistake the connection between fermentation and the growth of the sugar-mould, and it is highly probable that the growth of this mould is the cause of the phenomenon attending fermentation. As, however, it is necessary, in order to produce a fermentation, to have a nitrogenous substance present, as well as sugar, it seems that the presence of nitrogen is a condition which must be complied with for the purpose of furthering the development of this plant, and hence, that the plant itself contains nitrogen." These last words may be read in connection with those of an Italian chemist, Fabrioni, who in 1787 discovered the yeast ferment to be what he termed a "vegeto-animal" substance—that is, a body which gives off ammonia when burned, and is similar to the albumen and casein of animals, or the gluten of plants.

Turn to the dryest of dry-as-dust journals, the *Annalen der Pharmacie*, and selecting Volume XXIX., read from page 100, onwards, "When yeast is shaken up with water it appears, if examined under the microscope, to consist of infinitely small globules, and of fine threads, unquestionably composed of some kind of albumen. If you place these globules in sugar-water, it becomes evident that they are the eggs of an animal; they swell, burst, and therefrom issues a minute organism which reproduces itself with astounding rapidity, and by a hitherto unknown method. The appearance of this animal differs widely from any of the six hundred species at present described; it is like a Beindorf distilling flask, without the condensing tubes. The neck of the flask, which acts as a sucking trunk, is lined with fine hairs, but both eyes and teeth are missing. Stomach, intestines, anus (a small rose-coloured point), and urinary organs are all developed. At the moment of release from the egg, one can see the animals imbibe the sugar-water with great relish, and also witness the passage of the sugar into their stomachs. Digestion follows at once, and alcohol passes from the intestines whilst carbonic acid escapes from the urinary organs. . . . If the liquid be boiled, fermentation ceases, because the animals are unable to live at such high temperatures. Excess of alcohol, sulphurous acid, or any mineral acids, are likewise fatal to these creatures." Thus writes the ribald scoffer, and with diabolical ingenuity explains that, all the sugar being decomposed, these marvellous creatures of his fancy eat one another, "digesting everything but the eggs, which pass out once more and furnish material for further fermentation."

Despite this obvious satire (one wonders how it ever got into the *Annalen*), the vital theory of fermentation would, in all probability, have been accepted, had it not happened that another giant intellect visited our orb, in the person of Justus von Liebig. It must be related of Liebig that he opposed the vital theory of fermentation, but when he came across the memorable words of Ernst Stahl, he undoubtedly brought the full force of a chemical mind to bear upon them, and so we find the molecular theory of Justus von Liebig is an amplification of that espoused by Ernst Stahl, extended and fulfilled by some few facts his experiments had taught him. We can thus present the Liebig theories:—The component particles of a decomposing body are in constant motion, and this motion is, of a necessity, conveyed from one body (the cause of fermentation) to the substance with which it is in intimate contact (*e.g.*, the dissolved ingredients of the brewers' worts). Liebig exerted his knowledge to the utmost in order to gainsay his opponents, and we can find numerous echoes of his opinions on these matters, interspersed between the lines of sundry volumes, translated, in his early years, by the late Lord Playfair, as well as in the translations of Liebig's works furnished by Gregory and Blyth. It seems passing strange to us that a mere mechanical theory should have taken root, when Caignard de la Tour, Schwann and Turpin, had spoken; but such it was, and until Pasteur had dashed their idols to the ground, a process further effected by Tyndall and Huxley in later years, men scoffed for the most part at Turpin's remarkable words. They run thus, and we will accept them as truth until convinced to the contrary: "Vegetation as cause, and fermentation as effect, are two things inseparable in an act of sugar decomposition."

Berzelius, who, said Prof. A. W. Williamson, "had been for a lengthened period the one great man in the domains of inorganic chemistry," and who himself declared he had made his greatest discovery in unearthing apothecary Scheele, laid siege to both the theories of Schwann (vital forces) and Liebig (mechanical forces), and steered his way through the mudbanks of controversy by declaring the characteristics of yeast to be but the natural attributes of an amorphous precipitate. Also one Ehrenberg declares that many amorphous deposits may be observed in wreath-like forms, a bare initial fact revealed by hasty microscopic peeping. The Swede, Berzelius, did, of a surety, endow his amorphous precipitate with certain catalytic forces, and we find, in the pages of *Poggendorf's Annalen*, a well-known man, called Mitscherlich, came to somewhat like conclusions. He, Mitscherlich, describes his force as that of contact, and quotes, with due erudition, the mysterious action of platinium sponge on hydrogen per-oxide. And yet more theories echo from these times, mostly buried now in the tombs of Meissner, who verily believes the action of yeast is purely chemical, of Colin and Kamtz, and other men of science, who deem the whole matter connected with electrical phenomena.

Let us just put together the three or four main schemes of fermentation, as set forth by as many eminent philosophers. In the first place, we will put the vital theory, so well defined in Turpin's words already quoted. It finds support, at one time and another, from Caignard de la Tour, Schwann, Kützing, Van der Brock, Bichat, and lastly the illustrious Pasteur. As against this vital theory, we must place that of mechanical forces, originated by Stahl and Willis, and championed by Justus von Liebig, aided and abetted by Gerhardt. Then, again, the theory of catalytic forces, or contact-action, as set forth by Berzelius and Mitscherlich, has to be reckoned with, so that when, in the fulness of time, Pasteur uttered his mandate, it brought immense relief to the minds of all concerned therewith. "My firm opinion," said Pasteur, "is that the chemical act of fermentation is a correlative phenomenon of a vital act, both beginning and ending with such an act. I cannot conceive the possibility of alcoholic fermentation, without there being, at the same time, organisation, development, growth of new globules or the continuation of consecutive life of globules already formed."

The question now naturally arises, whence came these globules? The records of earliest times teach us of races of human beings who are deeply convinced of the truth of spontaneous generation, allied, in some cases, to an erudite philosophical conception which declares life itself is but an, almost, chance attribute of certain molecules, which themselves form the basis of all things living.

But perhaps it is chiefly due to a deep-thinking Catholic priest, Needham, Fellow of the Royal Society, that the true cause and nature of fermentations was first suggested. How he sprang upon the idea of boiling solutions in bottles, and then closing them up, we can scarce relate, but it is to his eternal credit that he actually did first boil and then seal, and thereby Needham obtained the master-key which unfolded the portals guarding all the glories of modern bacteriology. We are reluctant to record that Needham's boiled solutions did not keep for any length of time, but another learned cleric, one Spallanzini, soon defined the reason thereof, and, having subjected the liquids to prolonged ebullition, he straightway hermetically closes his flasks. In such-like manner was the time-honoured theory *generatio aequivoca*, of spontaneous generation, first laid in dust and ashes. Men began to realise what marvels and mysteries were borne on each passing breeze; they divined the *ursprung* of the fermentations that attacked sugar solutions and meat broth; and, moreover, the teachings of science were applied in most practical manner, as in the classic arrangements of Appert. Scheele was the first to initiate the process we now call "pasteurizing," or the sterilization of changeable materials by heat.

From many experiments, Gay-Lussac (1778-1850) was enabled to utter forth strange revelations as to the robbery of oxygen from the air imprisoned in hermetically closed flasks containing putrescible materials, whereby men had but little difficulty in connecting this gas with the urgent demands of all life. And from these points onwards we have witnessed the teachings of Pasteur and Hansen, the former of whom has already been cited, whilst the latter, as the great biological and botanical expert of yeasts, does not come directly under the category of subjects we are at present discussing.

The present-day theorists are divided into two distinct schools, namely: those concerned with the vital theory, and the others who, to some extent, espouse a reversion to older chemical hypotheses known as Professor Buchner's zymase theory. The learned Tübingen professor succeeded in extracting from living yeast cells an enzyme, or soluble ferment, which he calls zymase, and which has been proved capable of inducing the same alcoholic fermentation as that hitherto accredited only to the living and multiplying yeast cells. Numerous other men of science have confirmed these startling experiments, amongst others, our English botanist, Reynolds Green, who detailed his work on the subject at the Bristol meeting of the British Association for the Advancement of Science. The idea is in reality a revival of similar theories advanced half-a-century ago by Traube and Hoppe-Seyler, but Buchner has been able to support his hypothesis by actual experiment, an indispensable adjunct lacking in many earlier commentaries on fermentation. The battle is still being waged, and it is not possible for us, at present, to adjudicate victory to either side.

In conclusion, we must offer most humble apologies to a vast host of learned shades, the offspring of whose imaginative brains we have had neither leisure nor desire to exhume. Their strange theories, and stranger personalities, belong to a long-vanished past, and we have not deemed it wise to drag them from out the "dark backward and abysm of Time." Our barque has been borne, with exceeding rapidity, down the stream of many ages; it only remains for us to ask, Where will she find a haven in the centuries to come?

British Ornithological Notes.

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Bird Protection. — At the annual dinner of the British Ornithologists' Union the following excellent resolution was proposed by Mr. E. G. B. Meade-Waldo, seconded by Mr. H. M. Upcher, and carried unanimously:—"That any member of the Union, directly or indirectly responsible for the destruction of nest, eggs, young or parent-birds of any of the species mentioned below—Osprey, Kite, White-tailed Eagle, Honey Buzzard, Common Buzzard, Hoopoe, Golden Oriole, Ruff, Bittern and Chough—should be visited with the severest censure of the Union." It is to be hoped that this resolution will deter those members who are in the habit of purchasing British taken eggs from buying the eggs of these birds, and thus becoming indirectly responsible for their destruction. All the birds mentioned will require the strictest protection in Great Britain for many years before they can again become at all numerous. All the laws—and now there are many for bird protection—are practically useless as long as buyers of eggs and skins insist on having British taken specimens. And, after all, it is only a matter of sentiment that the eggs or birds should be British taken. There are many places abroad where the species named above are common, and the birds and eggs taken there are precisely similar to those taken in England or Scotland. And yet ornithologists, who know perfectly well that these birds are fast dying out in Great Britain, create a demand for their eggs and skins. We know of a dealer—would that we knew his name—who has lately taken many clutches of the eggs of the Kite in Wales, where these birds are said to still "hold their own!"

The Great Shearwater in Scottish Waters. By Alfred Newton, M.A., F.R.S. (*Annals of Scottish Nat. Hist.*, July, 1900, pp. 142-147.) This is a very interesting contribution from the pen of Prof. Newton, who, in company with Mr. Henry Evans, on two separate occasions saw an extraordinary number of these birds off the west coast of Scotland. On the 27th of June, 1894, between thirty and fifty pairs were seen between Lewis and North Rona, while on June 24th, 1895, a still greater number were seen near St. Kilda. Prior to this the known instances of the occurrence of the Great Shearwater in Scottish waters did not amount to many more than six. A point of great general interest was brought out by this "visitation" of Great Shearwaters. Several specimens were obtained by the fishermen of St. Kilda. From the examination of these birds, other skins and figures, Prof. Newton comes to the conclusion that members of the group *Tubinares*, which contains some of the birds best endowed with the power of flight, so moult their wings as to become almost, if not quite, incapable of it.

Scops Owl in Shetland. (*Annals of Scottish Nat. Hist.*, July, 1900, p. 184.) Mr. Eagle Clarke has received a wing and leg from the island of Foula, which he identifies as those of *Scops giu*. The bird was first seen in April of this year, and was eventually captured and kept in confinement. The recorded instances of this Owl in Scotland are very few in number, and it has never before been known to visit the Shetland Islands.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

The Annual Awards of the Royal Geographical Society.—The annual awards of the Society have been made as follows for the present year: The Founder's Medal to Captain H. H. P. Deasy, for the exploring and survey work which he has accomplished in Central Asia; the Patron's Medal to Mr. James McCarthy, for his great services to geographical science in exploring and mapping all parts of the Kingdom of Siam; the Murchison Award to M. H. Arctowski, for the valuable oceanographical and meteorological work which he performed on the Belgian Antarctic Expedition; the Gill Memorial to Mr. Vaughan Cornish, for his researches on sea-beaches, sand-dunes, and on wave-forms in water; the Back Grant to Mr. Robert Codrington, for his journeys in the region between Lakes Nyasa and Tanganyika; the Cuthbert Peck Grant to Mr. T. J. Alldridge, for his journeys during the past ten years in the interior of Sierra Leone.

Notices of Books.

"Pre-Historic Times." 6th Edition. By the Rt. Hon. Lord Avebury. xxiii. and 314 pp. Illustrated. (Williams and Norgate.) 18s. The distinguished author (better known as Sir John Lubbock) of this ever-popular work is to be heartily congratulated on the issue of its sixth edition. Since the publication of the second edition in 1869 no special preface has appeared, and it is therefore necessary to compare the present volume with the fifth edition (1390) in order to see how much it has been improved. The number of pages is somewhat less than in its predecessor, but the plates have been greatly increased in the present issue, partly owing to many of the figures which formerly appeared in the text having been incorporated in the plates. Specially noticeable is the replacement of the coloured frontispiece of the fifth edition by an exquisite photogravure of the well-known tumuli at Upsala; and there can be no question in its present guise, so far as illustrations are concerned, that the sixth edition is immeasurably superior to the fifth.

Numerous additions have likewise been made in the text in order to aid in bringing the book abreast of modern advances in science, the work of the Messrs. Sarasin on the Veddas of Ceylon being alluded to (perhaps too briefly) on p. 415, while Prof. Hughes's memoir on prehistoric and other cattle receives mention on p. 195. Strangely enough, however, the author seems to be unaware of the existence of a work entitled "Wild Oxen, Sheep, and Goats of All Lands," published by Mr. Rowland Ward in 1893, in which many of the views advanced in the present volume are controverted. And in regard to both wild and tame members of the genus Bos the author would have done well to have consulted a specialist, or at least to have walked carefully through the galleries of the Natural History Museum. We should not then have been told that the European bison is now confined to Lithuania (p. 197), or that it is identical with the aurochs. Neither would the reader have been puzzled by the confusion in regard to the proper scientific name of the extinct wild ox of Europe (the true aurochs), as will be apparent by comparing the tables on pp. 183 and 223. Again we find the elk, roebuck (p. 155), and reindeer (p. 263), which respectively represent three totally different genera, all included in the genus Cervus, whereas the so-called Irish elk, which is a Cervus, figures as a genus apart (p. 263). As another example we may notice that the marten appears as Mustela martes on p. 133, and as Martes sp. on p. 223; and many other similar instances might be cited. Nor are misprints by any means wanting, as, for instance, Sus palustris on the head-line of p. 192, instead of Palustris, Cervus elephas, p. 223, for Elaphus, and Lagomys fusillus, p. 273, for pusillus.

These critical remarks are made in no hostile spirit, but rather to emphasize the necessity for calling in the aid of a specialist when an author has to deal with a subject in which he is not thoroughly at home.

As a matter of fact, it is the portion relating to mammals which forms the one weak part in the book, upon which in other respects we have nothing but praise to bestow. Were it a new work, we should call the reader's attention to the extremely interesting chapters relating to stone and bone weapons of all kinds, and also to the fascinating section devoted to the manners and customs of modern savages, but in the case of a work which has already obtained such a world-wide reputation this would obviously be superfluous, not to say impertinent. We may therefore conclude by the expression of the hope that the patronage accorded to the sixth edition of this famous work may be fully as extensive as that with which its forerunners were received.

"The Distribution of the Negritos in the Philippine Islands and elsewhere." By A. B. Meyer, M.D. pp. 96. (Dresden: Stenzel & Co.) 1899. The chief object of this excellent little work seems to be to disprove the widely spread idea that the short, round-headed, frizzly-haired, black people commonly known as Negritos form a substratum of the population over a large extent of the Malayan countries, and that they also occur in Formosa, as well as in certain districts of China, Japan, India, etc. For this theory, which was adopted by the late Sir William Flower, the French anthropologist Professor Hamy is mainly responsible. As the result of his investigations, the learned Director of the Dresden Museum (who has personally visited the Philippines, New Guinea, and many of the Austro-Malayan islands) comes to the conclusion that the typical Negritos are restricted to certain islands of the Philippine group, the Andamans, and some districts in the Malay Peninsula. In the Philippines these people are more numerous than elsewhere, although even there they form only a comparatively small proportion of the population.

A very important section of the work is devoted to the consideration of the relationship of the true Negritos to the Melanesian inhabitants of Papua, who are typically of taller stature, with a long and narrow type of skull. Short-headed people are, however, to be met with in Papua, who have been considered to represent a distinct Negrito race. But, following the lead of Mr. Maclay, Dr. Meyer is of opinion that Negritos and Papuans are essentially one and the same race. "A Negritic race," he writes, "side by side with the Papuan race nobody has been able to discover just because it does not exist, and it does not exist because the Papuan race, in spite of its variability, is on the one hand a uniform race, and on the other as good as identical with the Negritos."

Finally, Dr. Meyer is very emphatic on the futility of the craniometry as now practised, remarking that "the practice of describing a skull in detail will never lead to profitable results, and only burdens the literature of the subject beyond measure."

"Micro-Organisms and Fermentation." By Alfred Jorgensen. Translated by A. K. Miller, PH.D., and A. E. Lennholm. Third Edition. xiii. and 318 pp. (Macmillan.) 10s. net. So rapid is the growth of the branch of science with which this book deals that though the first edition appeared only seven years ago the author has found it necessary, in order to incorporate the new work accomplished in the interval, to entirely rewrite a large portion of the book and to enlarge it very considerably. The new edition differs from its predecessors in containing a biological treatment of several English high-fermentation yeasts, isolated from yeast used in breweries and distilleries in various parts of Great Britain; an account of the changes recently discovered occurring in yeast during its use in factories; and a description of lactic acid bacteria, and the use of pure cultures of them in dairies. We find with regret that the volume is not provided with an index. This is a somewhat serious omission in a technical book of this nature, which will be so largely employed as a work of reference. Fortunately this defect can be easily remedied, and we trust the translators will see that a complete index is provided in the next issue. The text is accompanied by some eighty-three clear and instructive illustrations, while the bibliography at the end of the volume, occupying as it does over forty pages, will prove of real service to students of bacteriology and to the scientific brewer.

"The Principles of Mechanics." By Heinrich Hertz, translated by D. E. Jones, B.Sc. (Macmillan.) 10s. net. "Presented in a new form" is the claim put forward in this treatise on the principles of mechanics. In it the author has endeavoured to give a consistent representation of a complete and connected system of mechanics, and to deduce all the separate special laws of this science from a single fundamental law which, logically considered, can, of course, only be regarded as a plausible hypothesis. He has chosen as his starting-point that of the oldest theories, namely, the conception that all mechanical processes go on as if the connections between the various parts which act upon each other were fixed, a method of procedure in which much scientific insight and imaginative power are required, and, with all its imperfections, the logical system of dynamics thus evolved with the greatest ingenuity and perfect mathematical form will be appreciated as a guide to the general characteristics of natural forces. It is a work unsuited for the systematic teaching of mechanics, in spite of the fact that it affords a complete survey of all the more important general propositions in mechanics. All the principles are there, it is true, just as the chemical composition of water is the same at the Poles and the Equator, but to bathe in the Arctic Ocean one needs hardening a little, and to read this book with profit it is necessary to approach it through a milder medium.

"Practical Physiology." 7th Edition. By M. Foster and J. N. Langley. (Macmillan.) Illustrated. 7s. 6d. Sir Michael Foster's book, first printed in 1876, and now having reached the 7th edition under the care of Drs. Langley and Shore, needs but a few words of explanation as to the modifications introduced in order to meet the present day requirements. While the original general arrangement remains practically the same, the sections dealing with chemical physiology and the physiology of muscle and nerve have been extensively revised, and we note with some regret that the portion on the dissection of the rabbit and dog has been omitted, because, as the authors say, "the specialization of study which has taken place in the last twenty-five years seemed to make this omission inevitable." Still, in our opinion, the book in its amended form will maintain a foremost place among laboratory manuals of its kind.

"Man and His Ancestor." By Charles Morris. vii. and 238 pp. (New York: The Macmillan Company.) 5s. Towards the end of his book Mr. Morris describes its purpose as being "to trace the evolutionary origin of man, in his ascent from the lower animal world to his full stature as the physical and intellectual monarch of the kingdom of life" (p. 225). We had come to the conclusion, before reaching his concluding chapter, that Mr. Morris had succeeded in giving, in a very attractive manner, a fair exposition of the present state of evolutionary ideas on the ancestry of man, so that we are able to congratulate him upon having satisfactorily completed the task he set himself. Starting with a rapid review of the vestigial structures found in the human body, Mr. Morris proceeds to detail the various relics of ancient men which have been discovered in different localities. The questions of the transition from quadruped to biped and the steps which led to a complete freedom of the arms are then dealt with, after which less technical subjects are considered, such as, the development of intelligence, the origin of language, the evolution of morality, and man's relation with things spiritual. We surmise that the majority of people who study books of this class are more directly interested in the theory of evolution so far as it takes notice of the moral side of man's personality, and they will be most anxious to know how this subject is handled. One or two sentences will serve sufficiently to indicate the author's view. "What we call sinfulness is largely a matter of custom and convention. Men cannot properly be said to sin when their actions are checked by no conscientious scruples, and what one people would consider atrocious instances of wrong-doing, might be looked upon as innocent and even estimable by a people with a different moral standard" (p. 221). Sometimes Mr. Morris shows an unfortunate disposition to forget his scientific resolutions and indulges in fanciful language, which is out of place in a serious treatise, e.g., "The love principle is the innate moral element of the universe. Its rudimentary form is the attraction between atoms, which expands into the attraction between spheres. We see a development of it in the magnetic and electric attractions, and a higher one in the sexual attraction that exists in the lowest organisms. Its expansion continues until it reaches the high level of human love and social sympathy" (p. 217).

There is now in the press, and will shortly be published by Messrs. Young in Liverpool, and Messrs. Porter in London, the Report on the conjoint expedition to Sokotra and Abd-el-Kuri, conducted in 1898-9 by the British Museum (represented by Mr. Ogilvie Grant, of the Zoological Department) and the Liverpool Museums (represented by the Director of Museums to the Corporation, H. O. Forbes, LL.D.). The expense of its publication is borne by the Museums Committee of the Liverpool City Council, and it is edited by Dr. Forbes. It will be illustrated by between twenty-five and thirty plates, chiefly coloured, depicting the zoological and botanical discoveries of the expedition, the ethnography of the islands, etc. The introductory chapters by the Editor give an interesting account, fully illustrated in the text, of the journey, of the islands, and of their inhabitants. The scientific chapters are contributed by Lord Walsingham, F.R.S., Prof Balfour, F.R.S., Mr. Boulger, F.R.S., Dr. Forbes, Mr. Ogilvie Grant, Mr. A. E. Smith, Col. Godwin-Austin, F.R.S., Mr. De Winton, Sir G. Hampson, Bart., Mr. R. I. Pocock, and other well-known naturalists.

BOOKS RECEIVED.

A Guide to Chamounix and the Range of Mont Blanc. By Ed Whymper. (Murray.) 3s. net.

A Guide to Zermatt and the Matterhorn. By Ed. Whymper. (Murray.) 3s. net.

The Year Book of Photography and Amateurs' Guide, 1900. (*Photographic News* Office.) 1s. net.

A History of Decorative Art. By W. N. Brown. (Scott, Greenwood & Co.) 2s. 6d. net.

The Fifth and Sixth Books of Euclid. By M. J. M. Hill. (Camb. Univ. Press.) 6s. net.

Ad Astra. By Charles Whitworth Wynne. (Grant Richards.) 7s. 6d. net.

The Philosophy of Many Things. By Mary Leicester. (Lloyd.)

Text-Book of Zoology. Part I.—Mammals. By Dr. Otto Schemeil. Edited by J. T. Cunningham, M.A. (Black.) Illustrated. 3s. 6d.

First Stage Botany. By Alfred J. Ewart, D.Sc. (Clive.) 2s.

Lavengro: The Scholar, the Gipsy, the Priest. By George Borrow. Minerva Library. (Ward, Lock.) 2s.

Flesh Foods. By C. Ainsworth Mitchell. (Griffin.) 10s. 6d.

Foundations of Analytical Chemistry. By Wilhelm Ostwald. Translated by George M'Gowan. (Macmillan.) 6s. net.

Functions of Squares. By M. A. McGinnis. (Sonnenschein.) 5s.

Results of Rain, River, and Evaporation Observations made in N. S. Wales, 1898. By H. C. Russell, C.M.G., F.R.S.

Domestic Science. By Thomas Cartwright B.A. (Nelson.) 2s.

Official Year-Book of the Scientific and Learned Societies, 1900. (Griffin.) 7s. 6d. net.

Introduction to Zoology. By Chas. B. Davenport and Gertrude Crotty Davenport. (Macmillan.) 6s.

Radiographic List. (Isenthal & Co.)

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

MENTAL PERSPECTIVE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The discussion which has been occupying the attention of the members of the British Astronomical Association of late concerning the well-known, but none the less curious, apparent enlargement of heavenly bodies when seen near the horizon* has called forth several ingenious theories to account for the phenomenon. That this enlargement of the sun or moon when seen on the horizon is purely illusory is acknowledged by all, so that it is evident some kind of mental deception is here at work which tends to falsify our estimates of distance and consequently of magnitude. It has been suggested, for instance, that, when looking at the moon near the horizon, we are unconsciously aided in our estimate of its distance by reference to intervening land-marks, such as trees, hills, or houses, the distance of which we already know, whereas, when looking upward at the moon in the zenith, there is nothing whatever to guide us. Now it has been observed that the distance of objects is almost invariably under-estimated when we are deprived of our usual land-marks, as, for instance, at sea, and it is suggested that by analogy the distance of objects in the zenith, or at high altitudes, is similarly under-estimated. Thus, the moon, sub-tending, as it

* *Journal of the Brit. Astro. Assoc.*, Vol. X., Nos. 1, 3, 4 and 5.

does, the same angle to us, whether on the horizon or in the zenith, appears to us larger in the former and smaller in the latter position, for, as pointed out by Mr. John Turner,† "of two bodies of equal *angular* magnitude, that which appears to us to be nearer we think the smaller."

The truth of this statement is, I think, exemplified in a very striking manner by the accompanying photograph (Fig. 1), which shows the foreshortened side of a villa seen "under conditions different from those in which our experience is usually gained." It is, in fact, a photograph taken through a 3-inch telescope, magnifying some 40 diameters, of the villa, distant about a mile and a half, and marked by an arrow in Fig. 2, which represents the naked-eye view of the same.

Now as this building is at a considerable distance from the observer its near and far ends are seen under practically the same visual angle, or, as a draughtsman would express it, the vanishing point of its lines is infinitely remote. Instead of the lines of the roof and first story appearing to converge as they recede, as would be the case if the house were really as near the spectator as the telescope apparently brings it, they are here practically parallel, and our usual ideas of perspective are consequently upset. So much, indeed, are we in the habit of mentally enlarging the reduced image of the far end of the house (knowing it to be as large as the near end) that in the present case, where the two ends are of practically equal angular magnitude, we still mentally enlarge the distant end so that the lines of the roof and the first floor appear actually to *diverge*

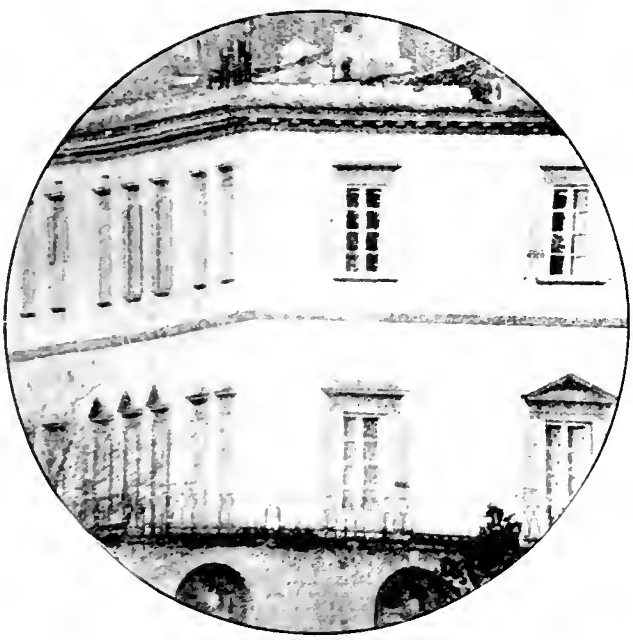


Fig. 1.

as they recede from us. That this curious effect, however, is purely due to a mental deception on our part is plainly shown by holding the picture in such a position that the eye can glance obliquely down the seemingly divergent lines, when it will at once become apparent that they are practically parallel; the slight existing convergence towards the distant end being inappreciable.

This instance of our mentally enlarging the more distant of two objects subtending equal angles seems to me to have a distinct bearing on the problem of the apparent enlargement of celestial bodies when seen near

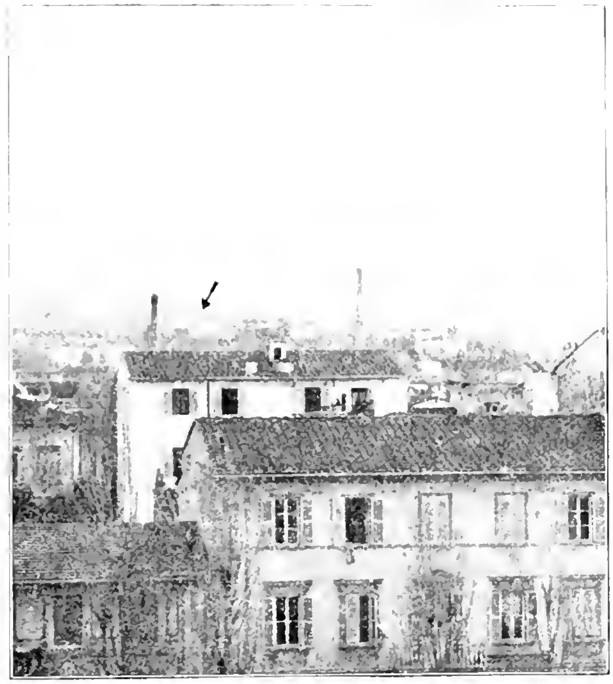


Fig. 2.

the horizon; while the tele-photograph itself illustrates in a remarkable manner the truth, so often overlooked, that the telescopic aspect of an object (which is but the naked-eye view enlarged) is not identical with that which the object would present to the naked eye at the same apparent distance. W. Alfred Parr.

34, Viale Principe Amedeo,
Florence.

† *Journal B. A. A.*, Vol. X., p. 220.

LICHEN GROWING ON QUARTZ

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The other day I was shown an entire piece of quartz upon which was growing a lichen—*Parmelia Prysodes*. After carefully removing a small portion of the lichen, I examined the uncovered part for earth deposits but failed to detect any.

It is clear that the plant is rooted to the quartz, and what I am at a loss to know is from which source other than the atmosphere does this plant derive its nutriment?

I have observed lichens acting upon hard rocks, but never quartz; moreover, as you assert in your article on "Plants and their Food," Knowledge, May, 1900, that quartz is an insoluble network enclosing the mineral constituents of plant food, the phenomenon becomes all the more egregious, and its explanation would bestow a great favour upon J. Alexandre Cook.

10, Grafton Square, Glasgow.
14th June, 1900.

[Mr. J. A. Cook has reproduced in too condensed a form the remarks of Mr. Pearson in Knowledge, Vol. XXIII., p. 102, where quartz is stated to surround the other minerals in granite, which otherwise would yield up the constituents needed by plants. This, however, does not affect the point he raises. I have consulted Prof. J. B. Farmer, F.R.S., who allows me to state that lichens growing on a surface of pure quartz may derive the very small amount of mineral nutriment required by them from blown dust, which easily accumulates about them, though in far too slight a quantity to form a soil. It may be remembered also that, while quartz-veins are fairly pure, quartzites contain a number of other scattered minerals besides quartz; hence some massive rocks, practically composed of quartz, may yet serve as a ground for the growth of lichens.

Grenville A. J. Cole.]

WIRELESS TELEGRAPHY.—III.

By G. W. de Tunzelmann, b.sc.

MECHANICAL REPRESENTATIONS OF ELECTRIC ACTIONS.

In my last article* some account was given of the medium through which electric actions are transmitted. All that I can do towards explaining the mechanism of transmission is to lay before my readers mechanical arrangements capable of producing the observed results, and which may not impossibly be something like the real ones, which as yet remain hidden from our view.

Clerk Maxwell was the first to give helpful suggestions in the way of mechanical models illustrating electric actions. His model was modified and improved by Professor Fitzgerald, and later Professor Oliver J. Lodge treated this question in a most exhaustive manner in a series of papers extending over the last twenty years. It is upon the store the latter has provided that I shall mainly draw at present.

We may consider ourselves as living in a sort of ocean of electricity, and as water is so much more familiar to us than electricity, it may help our conceptions to imagine for a moment that we are living under the sea, and consider the water as taking the place of the ocean of electricity really surrounding us, but the analogy then will not be quite complete. Water can be displaced by solid and other bodies, whereas in the electric ocean the amount of electricity contained within a given space is just the same, whether part of that space is occupied by matter of any kind, or whether it is what we call empty.

There is no possibility of putting electricity into any body in the way that we fill a bucket with water. When living under the water our buckets must always be full of water. We may change the water, but only by displacing it by an equal quantity from some other portion of the all-pervading ocean. As water cannot pass through the sides and bottom of the bucket, so in the same way insulators will not allow electricity to pass through them. The space occupied by the material of the bucket is not full of water, while the space occupied by an insulating material contains exactly the same amount of electricity as if the material were not there; but this will not seriously affect the use of the analogy. There is another and far more important difference between the two oceans; of water, and of electricity. While the water can move freely from one part of the ocean to another it is not so with electricity in so called empty space, this being an insulator. We find that electric waves can be sent through space, and therefore some small backward and forward motion must be possible but no continuous flow. The electric ocean must therefore be considered as entangled in a sort of jelly, which will allow of slight vibratory displacements, but in order to get a continuous flow some means of making tubes or channels in the jelly must be found, and these are called conductors.

In order to get a flow through a tube we must have some means of driving the electricity along, such as would be provided by a pump in the case of water, and for the flow to be continuous the tube must form a closed circuit. An analogy for a circuit composed partly of conductors and partly of insulators may be found in an endless tube containing diaphragms of some elastic substance, such as indiarubber, stretched across it at intervals.

A section of such a tube is shown in Fig. 1. The pump, A, has valves so adjusted as to send a current of water down the tube in the direction shown by the arrows. At B is an elastic diaphragm stretching across the tube. Before the pump is worked the diaphragm will be subject to equal pressure on opposite sides, and will therefore remain flat, as shown in section by the straight line, a, b, c. By working the pump the pressure on the right-hand side of the diaphragm will be increased and that on the left diminished, and the diaphragm will be bent into some such form as is represented by the curved line. If diaphragms are placed across the tube at each side of the pump, A, and the pump is then removed, and the tube divided through the diaphragm so as to leave each end enclosed, two tubes with their diaphragms will appear, as shown in Fig. 2, and the right-hand half of the tube will contain more and the left-hand half less than half of the water originally in the tube. These two tubes represent two equally and oppositely charged conductors, and it will be seen that according to this representation it is impossible to charge a conductor positively without at the same time giving an equal negative, or opposite charge, to some other conductor.

The greatest visible effects are produced when the whole of one conductor is brought as near as possible to the whole of the other while maintaining insulation between them. This is very conveniently done by pasting sheets of tinfoil on the inside and outside of a glass jar or on the opposite faces of a sheet of glass, forming the well-known Leyden Jar, and it will be seen that this consists simply of a pair of conductors insulated from each other, and that the case of charging or discharging any conductor is a case of the charge or discharge of a Leyden Jar.

Professor Lodge has designed an elaborate model of a Leyden Jar; Fig. 3 being a skeleton diagram, and Fig. 4 an illustration of the actual model.

A thin indiarubber bag is tied over the mouth of a tube provided with a stopcock, A, and the tube is inserted by means of a cork into a three-necked globular glass vessel. One of the other openings must have a stopcock, B, while the third opening is closed with a cork, or preferably another stopcock, as soon as the whole vessel, both inside and outside the bag, is filled with water free from bubbles of air. A third tube, usually closed by a stopcock, C, represents a discharger; and open gauge tubes, a and b, represent electroscopes attached to the two coatings of the jar respectively, while a water pump screwed on to A corresponds to a source of electricity, such as a battery, or a frictional or influence machine. If the two terminals of the source are attached to the two coatings of the jar, then A must be connected to B by means of a tube, while if one terminal of the source and one coating of the jar are connected with the earth, the more usual arrangement, then A and B must both be connected with a tank of

* Knowledge, May, 1900.

water representing the earth In this model the gradual distension of the indiarubber bag represents the charging of the jar. In Fig. 1, two extra stopcocks, A and B, leading direct to the tank, have been added, to save the trouble of disconnecting the pump in order to connect A directly with the tank, when illustrating the charging of a jar by alternate contact.

If the two tubes shown in Fig. 2 are placed together so as to form a single ring with two diaphragms across it, both in a state of strain, then if one of these is

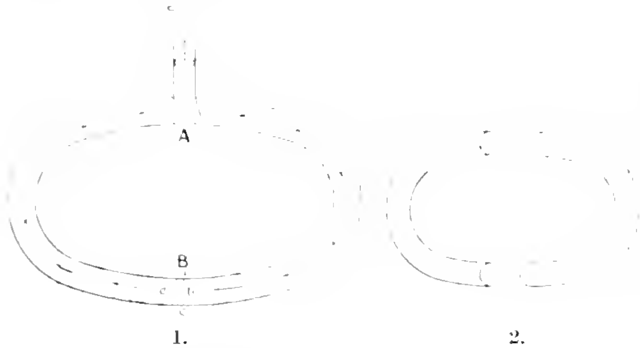


Fig. 1.—Hydraulic Model of a Circuit consisting partly of Conductors and partly of Insulators.

Fig. 2.—Hydraulic Model of a pair of equally and oppositely charged Conductors.

broken the pressures on the opposite sides of the remaining one will become equalised, and therefore the diaphragm will return to its normal condition of flatness. Owing, however, to the elasticity of the material of the diaphragm, there will be a slight oscillation on either side before it permanently assumes its position of equilibrium. As far back as 1853, Lord Kelvin showed mathematically that in general the discharge of a Leyden Jar was oscillatory, and in 1859 and subsequent years Feddersen confirmed this experimentally.

A current of water cannot be started or stopped suddenly, and similarly it is found that when an electric current is started it takes an appreciable time, though a very small one, to attain its full strength. Again, when an electric current is arrested by breaking the circuit, a very much larger spark is obtained than the one observed on closing the circuit, and the more sudden the break the larger the resulting spark. If, however, an electric current really possesses inertia, as a stream of water does, it should give rise to mechanical as well as to electrical effects. These have been looked for in vain by Clerk Maxwell, Professor Lodge, and others. It may be that an electric current consists of two equal streams in opposite directions; or, again, perhaps the hydraulic analogy is only of use in explaining a few of the more obvious phenomena; and it certainly does not account for the existence of the magnetic fields in the neighbourhood of conductors carrying electric currents or any of the phenomena depending on them.

The existence of these magnetic fields leads, moreover, to the question whether we can regard the electricity as forced along the conductor by a simple pressure, analogous to that which drives water along a pipe, or whether the energy required to maintain the flow is transmitted through the insulating medium to every portion of the boundary between it and the conductor. Professor Poynting has shown that the latter is really the case. The energy which drives an electromotor, for instance, or maintains a series of electric lamps, is not conveyed through the conducting wires. The dynamo gives its energy to the surrounding medium, thereby inducing certain strains in it which spread in all directions. If there were no conducting wires a permanent condition of strain would be set up in the medium, and when the energy reaches the conductors some of it is dissipated, and the continuous flow of a current of electricity thus becomes possible. When an attempt is made to transmit too much energy by means of an electric cable it is the insulation and not the copper wire which gives way.

An electric current does not start simultaneously at every point in the section of a conductor, but the starting or stopping begins at the outside, and penetrates inwards the more rapidly the worse the conductivity of the material. If this were infinite the current would never penetrate beyond the outer skin of the conductor.

Professor Lodge illustrates this by the experiment of spinning a tumbler of liquid, with some small particles in suspension, to make the motions of the different portions visible. The outer layers begin to move first, and the motion gradually penetrates inwards, and when the spinning of the tumbler is stopped the outside portions of the liquid stop first. If the liquid is very viscous, like treacle, the motions spread rapidly, corresponding to a bad conductor of electricity, but if extremely mobile then the inward propagation is much slower, corresponding to a good conductor. The analogue of a perfect conductor would be found in an absolutely non-viscous liquid, and in such the motion would never penetrate beyond the outermost skin.

Suppose now we wind a conductor into a coil and pass an electric current through it. We find that it behaves in every way as a magnet, in fact it is a magnet as long as the current continues to flow; hence Ampère's theory that magnetic substances owe their properties simply to electric whirls in their molecules. These whirls are not confined to the iron or steel of a magnet but spread into the surrounding space, forming what is

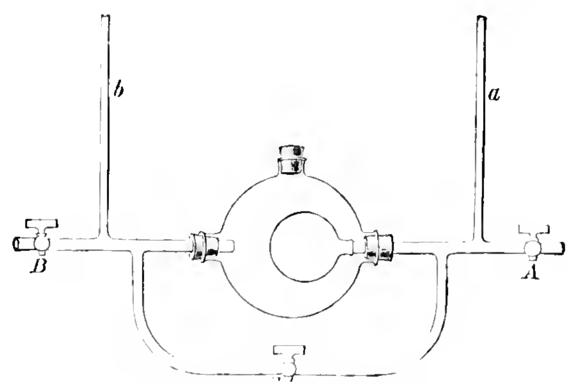


Fig. 3.—Skeleton Diagram of Lodge's Hydraulic Model of Leyden Jar.

From Lodge's "Modern Views of Electricity."

known as the magnetic field, and this may be mapped out by means of iron filings which cling, end to end, along lines coinciding at every point with the direction of the magnetic force, and are known as "lines of force." These lines of force must constitute the axes of molecular whirls, and every such line forms a closed curve, part of which is in the iron, and the remainder in the air or other surrounding media. The effect of such whirls, if they consisted of a material fluid, may be illustrated by means of a model suggested by Professor Lodge.

Two circular boards connected by elastic walls form a drum which can be filled with liquid. The upper board is then hung from a horizontal whirling table, while a weight is suspended from the lower one. When the drum is spun round, the sides bulge out, and the ends approach each other, raising the weight. A magnetic field will be represented by means of a number of chains, each made by attaching drums end to end, and following the contour of a line of force in the field. It will be seen then that when rotation is set up the end boundaries will be drawn together, representing magnetic attraction, while the lines of force drive each other apart sideways, representing magnetic repulsion.

Professor Lodge indicates the whirls in an insulating medium by means of cogwheels gearing into one another and also into those of the conductor, and in order to get over the difficulty that two contiguous wheels must be rotating in opposite directions, he assumes them to be equivalent to positive and negative electricity alternately. One of these models, representing a section of a magnetic field, is illustrated in Fig. 5, the wheels representing positive electricity being marked +, and those representing negative electricity being marked —.

If these rotate alternately in opposite directions the electrical rotation or circulation in the field will be all in one direction. In a medium of this kind, with all the wheel work revolving properly, there will be nothing of the nature of an electric current, for at every point of contact of two wheels positive and negative electricity respectively are travelling at the same rate in the same direction, but a current may evidently be represented by making the wheels gear imperfectly and work with slip, and a line of slip among the wheels will represent a linear current.

Professor Lodge points out that such a line of slip must always form a closed curve, as is required by the fact that electricity must flow in a closed circuit. For if only one wheel slip, the current coincides with its circumference; if a row slip, the direct and return circuits are on opposite sides of the row; and if an area of any shape with no slip inside it is enclosed by a line of slip the circuit may be of any shape but always closed.

In an insulator or dielectric there is no slip in the gearing, so a conduction current is impossible, but a metallic conductor must be considered as a case of friction gearing with more or less lubrication and slip; thus, turning one wheel will only start the next one gradually, so that, until all the wheels are in full spin, there is a momentary current. In a perfect conductor there must be no gearing, and such faultless lubrication that no spin can be transmitted from one wheel to another.

In a magnetic medium, which is not magnetised, the whirls are to be considered as taking place about axes pointing indiscriminately in all directions, or, more accurately, according to the researches of Professor Hughes, the various chains of whirls must form closed curves within the magnetic substance.

When the medium is magnetised these are broken up, and a preponderating orientation in a certain direction takes place, and this may be most simply treated by assuming that a certain proportion of the whirls are accurately faced in this direction, the others facing equally in all directions.

When a magnetic disturbance is propagated through an insulator in which all the wheels gear perfectly into each other, propagation of spin through the mass will take place with extreme rapidity, as there can be no slip, but only a slight distortion and recovery. In a conductor, on the other hand, so long as the spin is either increasing or decreasing, slip will be going on throughout, and a certain time will elapse before a steady state is attained. In highly magnetic substances, such as iron, and in a lesser degree nickel and cobalt, we know that this time is greatly increased, and may be represented in our model by increasing the mass of the moving wheelwork, either by giving greater mass to each of the wheels or by taking more of them, or by a combination of the two methods.

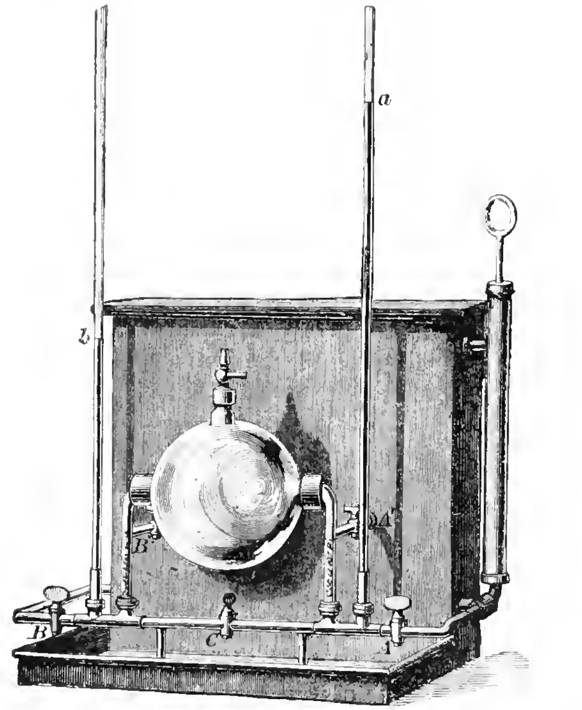
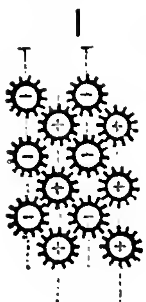


FIG. 4.—Lodge's Hydraulic Model of Leyden Jar.
From Lodge's "Modern Views of Electricity."

Take the case of a current in a copper wire gradually increasing and producing magnetic spin in the surrounding medium. A section of the field through the wire may be represented by a rack gearing into a train of wheelwork, as shown in Fig. 6. As soon as the rack begins to move the wheels will begin to rotate until the whole of the surrounding medium is in a whirling condition. Previous to a steady state of spin being attained the motion of the rack will be opposed by the inertia of the wheelwork, representing the opposing E.M.F. of self-induction, or electro-magnetic inertia, and, when the medium is in a state of spin, the stopping of the rack will be opposed in a similar manner. If the diagram is rotated round the rack the wheels become circular vortex rings. As the distance from the rack increases their cores increase in diameter, and therefore the rate of spin diminishes, until at great enough distances the medium will hardly be disturbed. Slip takes place entirely along the wire, while the axes of spin are at right angles to it. If slip could take place without friction, and the consequent dissipation of energy in the form of heat, we should have the analogue of a perfect conductor, if such a substance existed. As a matter of fact no such substance is known, and, therefore, in order to maintain a current in a conductor, the energy continually being dissipated in the form of heat must be continually supplied from some source of power, such as a dynamo or battery.

I want now to apply the foregoing representations to the explanation of the action of a telegraph wire as employed in ordinary telegraphy. What happens here is that a magnetic field at the sending station is made to excite a magnetic field at the receiving station with comparatively small loss. The wire makes it possible to produce this secondary field in any place desired. To understand how this is to be explained we will return to the consideration of the rack and train of wheels, but in the first place assume for greater simplicity that the wire is a perfect conductor. The rack must there-



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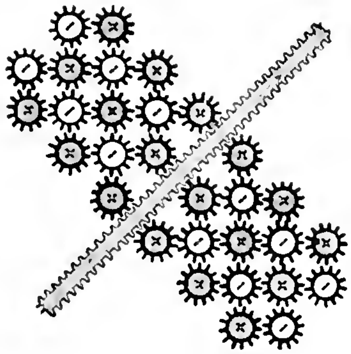

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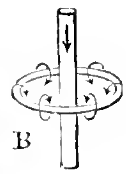

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Fig. 5.—Lodge's Model illustrating a Section of a Magnetic Field.

Fig. 6.—Lodge's Model illustrating a Section, taken through the wire, of a Wire carrying an Electric Current with its Magnetic Field.

Fig. 7.—Illustrating a Magnetic Vortex Whirl encircling a Wire carrying an Electric current.

From Lodge's "Modern Views of Electricity."

fore be removed and replaced by a smooth rod, so that the magnetic spin may cease at its surface and transmit no energy into the wire. Assume at the same time that the rotation of the wheels is in some manner maintained just as if the rack were being pushed along. Then in the bounding surface of the rod representing the conducting wire there exists the state of slip, which has been shown to correspond with an electric current, and it will be seen that the function of the rod or conductor is simply to provide a space free from the magnetic wheelwork, so as to allow of the free rotation in opposite directions of the wheels on the opposite side of any longitudinal section through the rod. If the space were not thus kept free the wheels would interlock, and the only magnetic field would be the ordinary state of spin about the lines of force, rapidly diminishing in intensity as the distance from the battery or other source of energy is increased. With this space, however, kept free by means of the perfectly conducting wire or smooth rod in the model, there will be an intense magnetic field everywhere immediately in the neighbourhood of the wire and diminishing in intensity as the distance from the wire increases.

All along the wire there will be, in fact, vortex whirls, as shown in Fig. 7, where B is a conductor carrying a current the direction of which is indicated by the arrow. The direction of spin of the positive whirls is shown by the curved arrows. All that is required in order to enable the wire to act in this manner is to have some arrangement capable of exciting vortex whirls about some portion of the wire, which must form a closed circuit, and these vortex whirls will then travel along the wire and produce their effect at the distant stations. These whirls are not found in the wire itself, but in the insulating sheath, so it will be seen that the wire transmits nothing, but only directs the energy on its way by holding apart the mutually opposing wheelwork of the insulator.

In practice the wire is not, of course, a perfect conductor, but the effect of this is merely that the slip on its surface is imperfect. Some of its own wheelwork is therefore set in motion, except along the axis of the wire. Two distinct results follow from this. In the first place, the frictional slip in the imperfect conductor causes a dissipation, into heat, of some of the energy supplied, and therefore only a portion of the initial energy at the sending station is transmitted to the receiving end. In the second place, every time the wheelwork is started, there will be a certain delay, increasing with the diameter of the wire, and which will also be comparatively large if the wheelwork of the conductor is very massive, as would be the case if an iron wire were employed.

THE LAND OF THE BASTIDES.

By Grenville A. J. Cole, m.r.i.a., f.g.s., *Professor of Geology in the Royal College of Science for Ireland.*

At a time when the authority of a central power was beginning to be felt, and when the free cities were being replaced by *villes royales*, dependent on the King of France, a number of fortified posts sprang up in the wilder country of the south, occupied by "king's men," and essentially military in design. From 1250 to 1350 a.d., these boroughs continued to accumulate, and to this day there are twenty-seven towns in central and southern France that are called simply La Bastide.

The original "bastida" of Provence may have had a high antiquity. It was a fortified farm, like some of those that are still inhabited on the flanks of the Juras, or in the English Pale round Dublin. The positions occupied by several of these strongholds can hardly have been neglected in Gallo-Roman days; but the bastide, as it now appears, dates mainly from the fourteenth century. Far away, you may see the yellow wall, with red-tiled roofs above it, and here and there a round tower at a corner, crowning a spur of the valley-side. Five miles on, you may spy another, and one more, perhaps, across the river, set against the pale hot purple of the sky. The roads occasionally desert the alluvium, and climb from one bastide to the next, passing in at a gate decked with some Palladian ornament, round the town between the ramparts and the houses, and out again into the blaze of sunlight, the permeating sunlight of Provence.

The landscape is a mixture of yellow and grey-green; the hillsides crumble in summer into brown and yellow earth; the quarries of soft stone are yellow; a yellow distemper has even seized upon the houses. The vines, on their posts and Roman trellises, are heavy with grapes, and dull with wind-borne dust; the trees along the road, planted by a benevolent government, have struggled through a joyless youth into a middle age of inutility. The hot air blows from Narbonne and the Mediterranean, and the pink haze hides both the Montagne Noire and the Pyrenees.

In this broad valley, where the head waters of the Gascon rivers almost touch those of the shorter eastern system, we see Fanjeaux, a fortress on the scarp, and Montréal, with its tall Italian campanile, and finally, grey and unbelievable, spreading in the distance like a dark wood along its plateau, the Cité of Carcassonne, roofed and towered as Froissart left it, *par excellence* the great bastide.

For a picture of mediæval France, with its Roman foundations and feudal superstructure, there is nothing finer than Carcassonne, the old town still cramped within the ramparts, and the *ville basse*, or commercial quarter, lying spread out in the plain below. The narrow streets of the latter, by-the-by, were laid out in the thirteenth century.

Those who in this country could not gain the heights walled themselves securely from attack in the alluvial level. Mirepoix, for instance, is boxed in like a town of the Bavarian plateaux,* and the road now runs round it, rather than enter the tiny gate, and pass, by wooden arcades, beneath the burghers' houses. The fact that, even at Carcassonne, horses are still fed in the grassy interval between the outer and the inner wall, shows how the country folk might find shelter in the *villes royales*, and serves to emphasise the parallel with Bavaria.

But here the essential feature is the enormous width of the valley-floors, not the uniformity of the plateaux. The lowland of the Garonne and its tributaries is 150 kilometres wide from the foothills of the Pyrenees to Marmande; and it is 110 kilometres (more than 68 miles) from Pamiers, through Toulouse, to where the Aveyron leaves the Jurassic plateau in the north. This country, so defined by nature, corresponds almost precisely to the Duchy of Gascony in the time of Charlemagne, a well marked region, with the Pyrenees for its southern march, and meeting Aquitaine along the line of the Ariège and the Garonne. Whoever held the passes of the Pyrenees almost held the heart of France. In the eighth century, the Mohammedan wave, which had submerged Carcassonne, isolated Toulouse, and reached the Atlantic, following the courses of the streams, surged even into the limestone plateaux, and was checked only at Poitiers. It is interesting to note how the central knot of granite, the country of Clermont-Ferrand and the Cevennes, broke the strength of the invasion, which ran up thence on either side, and devastated Autun on the east. Almost in our own time, the British forces, when once the Pyrenees had been rounded, pressed on from one stream to another to the foot of the plateau at Montauban.

This great plain of the Garonne, with the rivers streaming from the Pyrenees, is one of the most striking features of France, when viewed upon an ordinary map. The radial arrangement of the watercourses from the foothills near Bagnères de Bigorre makes the greater part of the country look like one huge delta. Some twenty of these streams are caught by the Adour, and enter the Atlantic at Bayonne; another twenty escape to the Garonne, and so are carried to the north. The lower portions of the two groups thus enclose between them the strange and wind-swept level of the Landes.

The tributaries reaching the north bank of the Garonne are far less neatly grouped, although some have made adventurous journeys from the east. The broad Gascon lowland has, indeed, received the waters from the central plateau, from the great volcanic knot of Aurillac, and from the bare limestone country of the Causses, as well as the rapid drainage of the Pyrenees. In Pliocene times, the elephants already found feeding-room in the Landes, and their remains became entombed in the alluvial clays. The sands of the district have accumulated since then, largely drifted from the Atlantic dunes; and the changes in land-tenure in the present century have led to a destruction of the forests, which alone held the soil together. The State has now been compelled to step in, and to defend the peasantry against themselves by a system of scientific planting. The contrast between this shifting country and the granite frontier of the Pyrenees is abrupt enough when one looks southward; it is a picture in little of the Himalayas and the alluvial plains of India.

Even the yellow rocks which underlie the surface-deposits, and which increase in antiquity as we trace them to the east, are not older than those of our London Basin. But the earliest among them have witnessed the uplifting of the Pyrenees. The marine fossils of the lower Eocene are included in the folds of the foothills at both ends of the chain; the warm sea of southern Europe once stretched across the site of the great ridges. Then the "Alpine" series of earth-movements set in beneath the whole of the European area, and a long east-and-west fold heralded the birth of the Pyrenees. The central mass beyond Bagnères de Bigorre, to this day the "Hautes Pyrénées," formed an island in Middle Eocene times,† and the southern tributaries of the Garonne thus began to flow before the main river was in existence. The relation is the same as that between the Alpine tributaries of the Danube and the Danube itself, which, when it came into being, caught in the smaller streams and systematised them.

The pebbles from the uprising Pyrenees now began to be carried down, and to form beaches and deltas, in which organic remains are rare. The whole floor of the nummulitic sea became a lacustrine region, and the marine beds cease with the close of Eocene times. Mirepoix itself, between the limestone foothills and the antique Montagne Noire, stands upon freshwater strata of the same age as those of Headon Hill in the Isle of Wight. Our southern coast of England, with its marine Eocene and fluviatile Oligocene strata, forms, indeed, an interesting parallel with the land of the Bastides. The vertical and folded chalk of Freshwater Bay represents the compacter Cretaceous limestones that lie along the flanks of the Pyrenees; the period of its uplift has been the same, and on its back we see the gravels worn from it, covering the lacustrine strata to the north, and reproducing the huge stream-deposits which have spread into the plain of Gascony.

The watershed between the Atlantic and the Mediterranean, west of Castelnaudary, is only some 200 metres above the sea. The easternmost tributaries of the Garonne, reaching to Labastide-d'Anjou, have almost touched the head-waters of the steeper Mediterranean streams. This innocent and unnoticed pass has now been traversed by a canal which is fed by the water of both systems. The real features of the landscape are the valley-walls of the Fresquel, running eastward, on a spur of which the bastide of Fanjeaux stands. The parting-ground, however, seems to have been determined as far back as Oligocene times; for the deposits of that period, both east and west of it, are of a freshwater and marshy nature. The submergence that occurred in the Middle Miocene epoch admitted the sea into the plain of Orleans, and far up the long depression that now forms the valley of the Rhône; but the bulge at Castelnaudary held its own, and the Pyrenean earth-movements were still making themselves felt beneath it. By Pliocene times, the whole lowland from Narbonne to Bayonne had been brought above the sea; the desolate Landes had made their appearance, a debating-ground for rivers and the Atlantic; and the

* *See* "Contrasts in Bavaria," KNOWLEDGE, June, 1900.

† *See* De Lapparent, "Traité de Geologie," 4me éd. (1900), p. 1433.

Garonne itself had begun to flow, its course being determined by the eastern and northern margins of the great detrital fan from the Pyrenees.

The rivers on the west of the watershed, in cutting their way down against the rising floor, have exposed nothing older than the marine and lacustrine Miocene deposits, which they are slowly washing away and distributing to form an even plain. The shorter streams on the east, however, notably the Aude, have carved out considerable valleys, and have even cleared their way down to the Cretaceous rocks before they enter the Mediterranean.

The Pyrenees, then, as a whole, are somewhat older than the Alps, and have undergone greater denudation and decay; but their highest elevation was reached in Middle Oligocene times, and marine Eocene strata have been raised 500 metres on their flanks. When we ride, as Froissart did of old, from the plain at Pamiers into Foix, the bold heights that soon close in around us are formed of Cretaceous and Jurassic limestones, squeezed against the knot-like older masses in the chain. The bare crag above Foix itself shows us how these strata have been bent and set on end; and here again, as in the Alps, the work was done, and the mountains were reared, within the limits of the Tertiary era.

In the cold epoch at the opening of Pleistocene times, the Pyrenees were still sufficiently high to feed a local glacier system. The tongues of ice streamed out into the plain, like those from the Alps into Bavaria. The limestone foothills are often found to be scoured and striated, and *roches moutonnées* may be seen, for an example, among the avenues of plane trees below Ax-les-thermes.

The barrier formed by the Pyrenees has naturally been sufficient to affect the human epoch. Just as the land of the bastides was long "Gallo-Roman" in its spirit, looking with suspicion on the Frankish barbarians who held it in their power from the north, so the recesses of the Pyrenees have never become wholly French, and their inhabitants in places speak Catalan, and come down, almost as foreigners, to the markets of Ax or Carcassonne. The passes, being little hindered by snow or avalanches, provide free access into Spain. The women, equally with the men, ride horses, mules, or donkeys, seated sideways upon sacks, after the manner of the mountain-folk; and the farmers come over, serious and straight-mouthed, driving highland cows, and thick-necked bulls, and herds of shaggy goats. The carts are drawn by three or four mules in line, the high collars decorated with scarlet tassels, and green cloths drooping on the animals' backs like veils. Every track is enlivened with the mule-bells and the cracking of whips in the keen air. The atmosphere of Spain itself clings to the mountains, despite the canals and the railways and the northern commerce that have invaded the old Gascon plain.

As a contrast to the geological youth of the Pyrenees, there rises north of the Fresquel and the Aude the old mass of the Montagne Noire.‡ This is one of the relics of an earlier France; it was elevated by successive Palæozoic movements, and formed one of the "Hercynian" ridges, even above the Permian sea. For a comparatively short period it became submerged in Mesozoic times; but the Upper Jurassic epoch saw it established again as a long-backed mountain, looking clear into the Spanish area, across water as yet unbroken by the Pyrenees.

The first folds of the Pyrenees found this obstacle waiting for them. The lacustrine and estuarine Eocene strata, and the Cretaceous limestones below them, were bent up on its southern flank, and now form the curious and bleak plateau, almost a "causse," that we meet as we rise north from Carcassonne. The unchecked wind from the Atlantic, or from the young and giant peaks to southward, sweeps the long slope, and beats on the forests of the crest. The labourers protect themselves, in this open landscape, by building little boxes of stone out in the fields. Wild thyme spreads freely, in default of any richer vegetation, and serves to remind one of the heather on the central plateau. As we ascend, the ravines cut by the streamlets expose ancient Palæozoic strata, Devonian, Silurian, Cambrian, or even the central gneissic core. Above us are gloomy woodlands, among which grey hamlets nestle, poor and isolated, Villardonnel, Cuxac-Cabardès, Labastide-Esparbairenque, names that suggest romance and brigandage in themselves. The summit reaches only 1000 metres above the sea, but the cold of the Grampians may be felt here on the latitude of Florence. The descent from Les Martys to Mazamet is a wild mountain episode, on a road swinging this way and that along the side of a fine V-shaped gorge. At one point a ruined fortress, rising from the torrent, only increases the sense of savagery. As we drop towards the open country in the north, we see as a background the blue highlands of Auvergne, and, far below, the red roofs of industrial Mazamet, a miniature Innsbruck, set on the alluvium of the Thoré.

The Montagne Noire forms an unexpected island in the yellow land of the bastides. It is one of those surprises with which France so frequently awaits the traveller. The railway from Calais to Bâle conveys a very false impression of the country; even the moorlands of Brittany, and the rolling fields of Normandy, are a mere foretaste of the greater France to southward.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

In his studies of slow motions Professor C. S. Slichter, by means of kinetoscope pictures, has so magnified the motions that the growth of seedling peas and beans during three weeks is shown in a few seconds. The plants were photographed on the kinetoscope film by artificial light at intervals of a few minutes to a few hours during the three weeks. On projecting the pictures upon the screen at the usual rate, the motion of growth was magnified about 500,000 times, and the different rates of development of the various parts were brought out very clearly. Among the striking results was the curious behaviour of a pea struggling to enter impenetrable soil, the root curving and writhing much like an angle worm, while the pea was rolled about very grotesquely.

Mr. C. Reichert, of Vienna, makes a new form of apparatus which may be used either for photomicrography, drawing, or projection. It consists of a stand, fitted with a stage capable of moving up and down, to which may be adapted either a photographic camera or a projection apparatus. It is intended principally for low power work, five to thirty diameters, and can be used either with petroleum, spirit, or gas.

A suitable ray film for photographing bacteria and other objects which have been stained with fuchsine, methyl blue, or gentian violet is prepared by dissolving 160 grammes of pure nitrate of copper and 14 grammes pure chromic acid in 250 c.c. of water. This solution permits light rays of wave length of from 570 to 550 to pass, and causes the objects stained with the above mentioned solutions to appear black on a green ground.

Experiments by E. Klein indicate that, contrary to common belief, such germs as those of cholera, typus, and diphtheria do not survive more than three or four weeks after burial in the ground.

Messrs. R. & J. Beck, of Cornhill, London, have recently put upon the market several new pieces of apparatus the most important

‡ *See* especially "Guide géologique en France," *7me Congrès géol. internat.* (1900), "Massif de la Montagne-Noire," by M. J. Bergeron. Also De Lapparent, *op. cit.*, p. 1791, &c.

of which are a Wide Angle Immersion Condenser with an aperture of 1.4 N.A., an aplanatic cone of 1.3 N.A., and a working distance of .06 of an inch. They have also introduced a new, cheap one-tenth immersion objective, with an aperture of 1. N.A.

The copper amalgam, known as Viennese metal cement, is well adapted for modelling the most delicate objects, and it is therefore of special value to the histological microscopist. The method of preparation is as follows: Copper is precipitated as a very fine powder from a solution of blue vitriol by means of strips of zinc, and after being washed and treated with a solution of mercurous nitrate, hot water is poured over the copper in a mortar, and the mercury, in the proportion of seven parts to three of copper, is added. The resulting amalgam becomes so soft under water that it can be used for modelling the most delicate objects from plaster casts. It hardens into a malleable mass that can be polished like gold and is not readily tarnished except by hydrogen sulphide, and it is a strong cement for metals. When impressions have been made on thin sheets the amalgam may be reinforced by pouring on molten type metal.

The Bausch and Lomb Optical Company has just issued a revised edition of a useful little manual entitled "Manipulation of the Microscope."

Corks that have been steeped in vaseline are an excellent substitute for glass stoppers without their disadvantages. They are not affected by acids or chemical fumes, and they do not become fixed by a blow or by long disuse.

The following process for preparing delicate specimens of hymenoptera for mounting is strongly recommended. The insects are placed in a wide-mouthed bottle containing an acid mixture made up of one ounce of pure, dry crystals of carbolic acid dissolved in four ounces of oil of turpentine, and are left to soak in this for a couple of days. A specimen is then taken out and arranged on a glass slip. A cover glass is placed over it, and sufficient pressure applied to flatten out the thorax. It is then placed between clips and allowed to stand in the acid solution for a day or two longer, after which it is carefully washed in filtered oil of turpentine, again placed between the clips and soaked in the turpentine for two or three days. This hardens the insect so that it can be easily handled without breaking. It is now ready to be mounted in moderately thin balsam.

The classification of fresh-water sponges is based upon the form and character of the spicules. As these are invisible to the naked eye, and are difficult to obtain without special preparation, the following method of development will be of interest to the student and to the collector alike. The spicules are embedded in the sarcode or flesh of the sponge, and the object of the processes of preparation is to effectually remove this organic matter. To do this place a fragment of the sponge skeleton and a few gemmules in a watch glass and apply a drop of nitric acid. Boil, and repeat the process until the sarcode and gemmule contents have disappeared. Thoroughly wash with distilled water, and stand on one side to allow of the spicules separating out.

Mons. B. Renault holds bacteria to have been a most powerful factor in the world's geological development. He believes that they transformed wood into coal, and that several species of the fossilized bacteria have been discovered in coal by himself and Professor C. E. Bertrand.

Formaldehyde is well known to the microscopist as an inexpensive and effective fixing agent. As a rule it is seldom used in solution stronger than ten per cent, and then generally in conjunction with mercuric chloride. The following formula has yielded very satisfactory results for normal tissues, the material being killed and fixed in the solution in from six to twelve hours. Formaldehyde 40 per cent. solution, 50 c.c.; distilled water, 50 c.c.; glacial acetic acid, 5 c.c. After fixing the tissues are transferred to three grades of alcohol, viz., 50 per cent., 75 per cent., and 95 per cent. respectively, and mounted in paraffine. Care should be taken to perform the operation of dehydration thoroughly, otherwise the sections will drop out of the embedding matrix when being cut. The tissue may be run back through xylol into absolute alcohol, and left until every trace of water is removed. If the specimen appears milky or opaque in the clearing fluid it is not ready for embedding, but needs to be left in alcohol for a longer time until dehydration is complete.

Beginners in microscopy frequently overlook the fact that it is possible to have the field of view too brilliantly illuminated. With ordinary powers it is necessary, in order to secure good definition of the finer details of the object, to moderate the brilliancy of the light either by the use of the diaphragm attached to the sub-stage or by moving the source of illumination further away. The result of a too brilliantly illuminated field of view is to "drown out" the details and render the image flat, and therefore a clear, small light is often a positive advantage.

Molluscan nerve tissues require careful treatment in the preliminary stages of preparation to ensure satisfactory mounts. An effective macerating fluid for this purpose is prepared as follows:—Acetic acid, 5 parts; glycerine, 5 parts; distilled water, 20 parts. After soaking the specimens in this for from four to twenty-four hours they are teased in fifty per cent. glycerine, or washed and stained in picro-carmine or ammonia-carmine.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* KNOWLEDGE.]

NOTES ON COMETS AND METEORS.

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

GIACOBINI'S COMET.—This object is now rapidly becoming fainter, with increasing distance from the earth. It will not be observable during the second week of August owing to moonlight, but a powerful telescope will reveal the object in the position assigned by Berberich in the following ephemeris (Ast. Nach. 3636):—

Date.			R.A.				Declination.				Distance in Millions of Miles.
			H.	M.	S.		°	′			
August 3	...		19	22	21	...	39	51	N.	...	113
„ 7	...		18	57	55	...	36	39	N.	...	117
„ 15	...		18	21	18	...	30	7	N.	...	130
„ 19	...		18	8	0	...	27	1	N.	...	137
„ 23	.		17	57	19	...	24	9	N.	...	146
„ 27	...		17	48	46	...	21	30	N.	...	156
„ 31	...		17	41	57	...	19	5	N.	...	164

Thus the comet's motion carries it rapidly through Lyra and Hercules. After August it will be an exceedingly faint object, and only visible in very large instruments.

RECENT COMETARY DISCOVERIES.—Very few new comets appear to have visited our parts of space during the last 15 months, judging from the number of discoveries, for only two have been found, and in both cases the first observer was M. Giacobini, of Nice. It is true that several periodical comets have returned during the period named, but on the whole comet seekers have met with very little success. It is, however, highly probable that we shall shortly hear of a discovery in this field, for the months of July and August have been the most prolific hitherto in furnishing us with new comets.

FIREBALL OF SUNDAY, JUNE 10.—A large fireball was seen in the twilight by several observers at widely distant stations. Lieut.-Col. Boilean, M.D., A.M.S., of Trowbridge, gave the time as about 9h. 10m., and described the meteor as passing about 15 degrees above Venus from N.E. to W. at an angle of about 30 degrees. Twilight was so strong that there was nothing visible in the heavens except the moon, Venus, and Jupiter. At Spilsby, Lincoln, the meteor was seen by Mr. J. Richardson, who says he first noticed it about 60 degrees above the horizon like a shooting star to the W.S.W. "After falling a few degrees at an angle of 75 degrees towards the S.W. it became very bright, and continued so for about 30 degrees more, when it seemed to break into several fragments and lose its light, finally diappearing rather suddenly about 10 degrees above the horizon. It was 2 seconds in falling, and appeared considerably more than double the diameter of Jupiter." The Rev. F. B. Allison, of Peasmarsh, gives the time as 9h. 12m., and says the first appearance was at some 10 degrees altitude. The meteor then appeared to traverse a meridian (8h. 30m about) and occupied 1½ seconds in passing over 10 degrees to a low cloud on the horizon behind which it disappeared. The brightness of the head was 1½ times that of Venus. The meteor left a short flaming tail of intense green colour, after which came a trail of sparks of several degrees in length; the meteor was slow. At Colwyn Bay Mr. W. B. Russell noticed it falling in the southern sky at 9h. 15m. p.m. The meteor was more than double the diameter of Jupiter, and it fell perpendicularly downwards, leaving a most brilliant copper green trail. Its course was very short. A friend who was with Mr. Russell thought the colour at first blue and green, and the nucleus of the meteor seemed to break into two fragments. Mr. A. Mee, of Cardiff, saw the meteor in the west about one-third of the way from the horizon to the zenith, but no further particulars are given as to the direction of flight or velocity.

Comparing the various accounts it appears highly probable that the meteor was a Cepheid, and from a radiant either at 336 + 73 or 310 + 77. The heights were from about 65 miles over Lampeter to 28 miles over a point near Worm Head, Gower, S. Wales, but these results are approximate, and more observations are required before the meteor's exact path in the air can be determined.

LARGE METEORS.—Mr. A. King, of Leicester, reports that on June 24, at 10h. 57½m., he saw a fine meteor of a beautiful yellow hue and brighter than Venus at maximum. The first part of the flight was not well seen, as the observer was not facing the object, but the latter part of the course was from 213° + 44½° to 203° + 22°, which it completed in 2½ seconds. The direction seemed slightly curved to N.W. The nucleus was stellar, and it left a short train. On Sunday, July 15th, 10h. 13m., a very brilliant meteor was seen at Bristol, Leeds, and Meltham, near Huddersfield. It exceeded Venus in lustre and was directed from a radiant at 297°—11°. It fell from a height of 51 to 21 miles from over Warrington to Ravenglass, on the coast of Cumberland. Length of observed path 78 miles, and velocity 16 miles per second.

August Perseids.—The moon being full on August 10 the splendour of this year's display will no doubt be greatly moderated. Notwithstanding moonlight, however, the shower may be expected to be sufficiently strong to enable its radiant to be determined on every fine night during the first 15 nights of the month. During the opening week of August the moon will not offer a serious impediment, and the shower may be watched to advantage in the morning hours. The exact place of the radiant on each of the first few nights of the month would be valuable, as very few determinations have ever been made at this early period of the shower's manifestation.

August Draconids.—Between August 21 and 25 a well defined and rich shower of Draconids, observed at Bristol in 1879, should be looked for. It is probably of periodical character, and does not appear to have been re-observed since the year referred to. The radiant is at 291° + 60°, near the small star o Draconis, and the meteors are bright and move slowly. In addition to these Draconids there are a large number of interesting showers visible during the last ten nights of August.

THE FACE OF THE SKY FOR AUGUST.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 4.24 and sets at 7.48; on the 31st he rises at 5.12 and sets at 6.48. Conspicuous sun spots are not to be expected, but small ones may occasionally be seen.

The Moon.—The moon will enter first quarter on the 3rd at 4.46 P.M.; will be full on the 10th at 9.30 P.M.; will enter last quarter on the 17th at 11.46 A.M.; and will be new on the 25th at 3.53 A.M. The brightest star occulted during the month is Iota Tauri, mag. 4.7; the disappearance takes place at 0.42 on the morning of the 19th, at an angle of 41° from the north point (81° from the vertex), and the reappearance at 1.24 A.M., at an angle of 304° from the north point (346° from the vertex).

The Planets.—Mercury is a morning star in Cancer, well placed for observation for a few days before and after the 20th, when he reaches greatest western elongation of 18° 32′. On the 15th he rises an hour and a half before the sun, on the 20th an hour and three-quarters before the sun, and on the 25th an hour and forty minutes before the sun.

Venus is a morning star, at greatest brilliancy on the 14th, nearly three-tenths of the disc being then illuminated. The path of the planet is easterly, from near Gamma Geminorum on the 1st to near 68 Geminorum on the 31st. The apparent diameter of the planet diminishes from 45″.6 to 29″.2 during the month. At the beginning of the month the planet rises shortly after 2 A.M., and at the end a little before 1.30 A.M.

Mars rises between midnight and 1 A.M. during the month. He is in the constellation Taurus (near Zeta on the 1st) until the 8th, when he passes into Gemini. The distance of the planet is so great, however, that the disc only subtends an angle of 4″.6 to 5″.0. At the middle of the month a little more than nine-tenths of the disc is illuminated.

Jupiter may still be observed for a short time in the evening; setting about 11.30 P.M. on the 1st and about 9.40 P.M. on the 31st. He is in the constellation Scorpio, his path being a short easterly one a little south of Beta Scorpii. On the 25th the planet is in quadrature with the sun. The satellite phenomena are most interesting—on the 3rd (9.59), 4th (8.48), 11th (9.6), 12th (8.34), 19th (8.11), 20th (8.56), and 29th (8.33).

Saturn may be observed up to about midnight through the first half of the month. The path of the planet is a very short westerly one in the western part of Sagittarius. On the 18th the apparent polar diameter of the planet is 16″.2, and the outer major and minor axes of the outer ring 40″.7 and 18″.4 respectively, the northern surface being visible.

Uranus remains in Ophiuchus, near to the star Omega in that constellation, a few degrees to the east of Jupiter; and may be observed only during the early evening. The planet is stationary on the 17th.

Neptune does not rise until after midnight during the greater part of the month. He is in the most easterly part of Taurus, one and a half degrees south of Mars on the 7th.

The Stars.—About 10 P.M. at the beginning of the month, Perseus and Cassiopeia will be in the north-east; Pegasus, Andromeda, Aries and Pisces towards the east; Aquarius and Capricornus in the south-east; Cygnus and Lyra nearly overhead; Aquila due south; Hercules and Ophiuchus towards the south-west; Corona and Boötis in the west; and Ursa Major in the north-west.

Minima of Algol will occur on the 4th at 11.55, on the 7th at 8.43, and on the 27th at 10.26.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of July Problems.

No. 1.

(B. G. Laws.)

Key-move 1. Kt to B6.

If 1 . . . R × P,	2. B to K4ch, etc.
1 . . . B × RP,	2. Q to K4ch, etc.
1 . . . R to Kt3,	2. Q × Pch, etc.
1 . . . Kt to B2,	2. P to Kt4ch, etc.
1 . . . K moves etc.	2. B to R5 etc.

No. 2.

(W. H. Gundry.)

Key-move—1. Kt to Q4.

If 1 . . . K × Kt,	2. Q to Q6, etc.
1 . . . P to R5,	2. Q to B2ch, etc.
1 . . . K to Kt5,	2. Q to Q6ch, etc.
1 . . . Kt moves,	2. Q to QB6ch, etc.

Correct Solutions of both the above received from H. Le Jeune, H. S. Brandreth, G. A. Forde (Capt.), G. W. M., W. de P. Crousaz, J. Baddeley.

Of No. 1 only from K. W.

Of No. 2 only from Alpha.

Mr. Macmeikan's sui-mate is solved as follows:—

1. B to QR2, P moves.
2. R to K6, P moves.
3. B to B6, P moves.
4. R to K3, P moves.
5. Kt (Q3) to K5ch, R to Q6.
6. B × P, R × R
7. B to Ksqch, R × B mate.

Alpha.—You will see that your inspiration as to the key of No. 1 was correct, though not completely followed out in the main variation.

A. B. Watson.—I have not the problem by me, but think you will find it all right.

W. Parkinson.—After 1. P - B (Q) ch, R × Q; 2. Q to K7, K to Kt3; 3. Kt to K5ch is not mate.

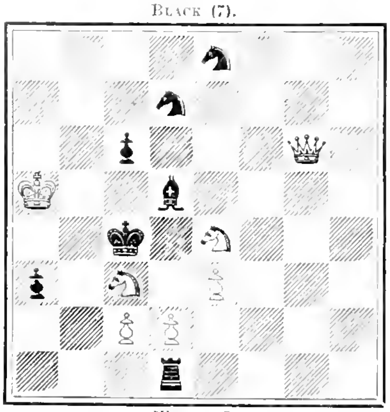
G. W. M.—I regret that I cannot decipher your signature, so have given initials only. You will see that your first move only in the sui-mate is correct.

PROBLEMS.

No. 1.

From the *Manchester Weekly Times*.

Black (7).



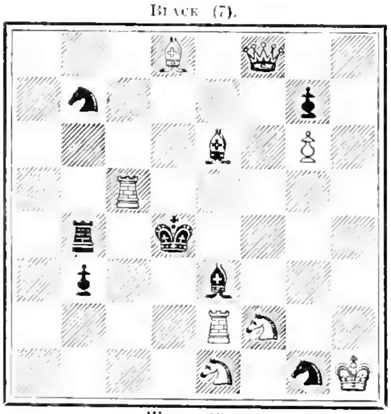
White (7)

White mates in two moves.

No. 2.

By A. F. Mackenzie (Jamaica).

Black (7).



White (9).

White mates in three moves.

"A Memorial of the City of London Chess Tournament" (Longmans, Green & Co.). It is not often that a book on chess, or any other game, is so artistically got up as this record of the recent invitation tournament for masters and amateurs, which was held at the City of London Chess Club in April and May, 1900. The volume contains the whole of the 78 games played in the tournament, together with the original programme of play, the score-sheet and an index of the openings. Another instructive table gives the relative successes of the different openings played: the success attending the Sicilian defence is especially noteworthy, as is the failure of the French defence. There is evidently nothing much in the Ruy Lopez, but the Queen's Gambit declined comes out badly for the defence. The book is published at 2s., and may be obtained from Mr. J. W. Russell, Hon. Sec., City of London Chess Club, 7, Grocers' Hall Court, E.C., for 1s. 6d. (1s. 8d. post free), or seven copies will be sent post free for 10s.

CHESS INTELLIGENCE.

Brighton Society announces its twelfth Problem Tournament for direct mates and sui-mates in two moves. Three problems may be sent in for each section, and there will be three prizes in both classes. Competing problems must reach the Chess Editor, 93, Richmond Road, Dalston, N.E., by December 1; or from abroad by January 1, 1901.

The following is the result of the Paris International Tourney:—

E. Lasker, 14½, 1st prize £200 and Sevres Vase.

H. W. Pillsbury, 12½, 2nd prize £100 and Sevres Vase.

F. Marshall, 12, 3rd and 4th prizes £80 and £60 divided and Sevres Vase.

G. Maroczy 12, 3rd and 4th prizes £80 and £60 divided and Sevres Vase.

A. Burn, 11, 5th prize £60.

M. J. Tchigorin, 10½, 6th prize £40.

G. Marco, 10, 7th and 8th prizes £16 and £8 divided.

J. Mieses, 10, 7th and 8th prizes £16 and £8 divided.

C. Schlechter, 10; D. Janowski, 9; J. W. Showalter, 9; J. Mason, 4½; N. Brody, 4; Rosen, 3; J. Mortimer, 2; M. Sterling, 1; and Didier, 1.

The prizes of £20 and £12, presented by Baron Albert de Rothschild, of Vienna, for the best games played during the tournament, have been awarded to Mieses for his game against Janowski, and to Tchigorin for his game against Mortimer.

Mr. Lasker's score of 14½ out of a possible 16 is one of the best on record, and will, if possible, enhance his reputation. He lost only to Mr. Marshall, and drew with M. Tchigorin only when already certain of the first prize. Of the rest, Messrs. Pillsbury, Maroczy, Burn, Tchigorin, Marco, and Mieses came out in or near the places which might have been predicted for them, but Herr Schlechter and M. Janowski are accustomed to higher flights. The latter's performance is especially disappointing as he made an excellent start. The immense gap between Mr. Showalter and the last six players is most noticeable. It is most disappointing to find Mr. Mason in this latter category; better things were also expected of Herr Brody.

Many of the competitors will take part in the Munich Chess Congress which begins on the 21st of July. This will be limited to eighteen competitors without regard to nationality, and may be nearly equal in quality to the Paris tournament.

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HIGH-SPEED TELEGRAPHY.

By Chas. H. Garland.

Last year the lovely little town of Como held a great *fête* to celebrate the Volta centenary. Truly it has cause for pride. The town made famous by the two Plinys was the birthplace of the man who discovered a force which bids fair to revolutionise the industry of the world. In discovering the pile, the forerunner of all the electrical batteries we know to-day, Volta made possible the production of the first constant current of electricity, and thus laid the foundation of all later developments.

A part of the celebrations consisted in a Congress of telegraph experts from all corners of the civilized globe. The world was ringing with the name and fame of Marconi, a native of Bologna, and the attention given to his wireless telegraphy absorbed the public interest, so it escaped notice that at one of the sittings of the Congress, Hofrath Josef Kareis, of Vienna, gave a brief description of one of the most striking inventions of modern times—the work of Anton Pollak, a Hungarian electrician, and Josef Virág, a Hungarian mechanician. It was claimed for this marvel that it could transmit telegraphic messages over long distances at the astounding rate of sixteen hundred words per minute.

In order to understand the full significance of these figures, we must take a brief glance at modern telegraphy and the speeds hitherto attained. Nearly the whole of the English telegraph work is carried out by some adaptation of the Morse system, involving the use of certain signals produced either by some printing apparatus for sight reading, by some sounding apparatus for reading by the ear, or by any other method which will appeal to the senses. It is employed in flag signalling, lamp and heliograph signalling, and in some half dozen systems of telegraphy. The short and long signals, however produced, are known as "dots" and "dashes." Thus, a dot followed by a dash is A. A dash followed by three dots is B. Dash, dot, dash, dot, is C, and so on.

The fastest method of telegraphy, unassisted by automatic appliances, is known as the "sounder." This is essentially a small hammer which, in response to currents sent from the sending office, strikes upon a brass upright and produces a short or longer tap, which the listening telegraphist translates into writing. By this system a good telegraphist can send and receive, for a short period, as many as 45 words per minute. The speed at which a clerk can receive is limited, for all practical purposes, by the speed at which he can write. So for an apparatus which is read by sound, and leaves no printed record of the signals which can be afterwards transcribed, a higher speed is useless.

There are on the average three signals to each letter of the Morse alphabet, and the length of the telegraphic word is, as a rule, five and a half letters. In order, then, to receive 45 words in a minute, a telegraphist must discriminate the various characters of 720 signals or taps. As the space between the taps is of almost equal importance with the taps themselves, he has to measure the length of an equally large number of silent intervals. A clearer idea of what this speed means can be obtained if we remember that a watch ticks about 160 times per minute.

In the Wheatstone system the sending is done by means of an automatic transmitter. The perforating of the ribbons is performed very rapidly, and I have seen telegraphists work at the rate of over 50 words per minute. A large number of telegraphists can be employed in preparing ribbons which may be continually passed through the transmitter at the rate of 100 words per minute. This means that 6,600 signals are sent over the wire in one minute, a speed seldom exceeded in actual working.

At the receiving office the signals are printed on a narrow green ribbon, and consist of shorter or longer black lines, which represent the conventional dots and dashes. When the green ribbon has been received it is cut up into sections and distributed among a number of writing clerks, who transcribe it. In this manner it is possible to keep a large number of clerks fully employed at either end of the wire, and so avoid what is the chief expense in telegraphy—the building of new trunk lines and maintaining them in repair.

Up to the time of the invention of the Pollak-Virág system, the Wheatstone automatic telegraph was the most rapid of the high-speed telegraph systems. It is true that an American system, invented by Crehore and Squire, attained a tremendous speed in the experimenting room, but the details were so complex, and the electrical difficulties so great, that it was never put to practical use.

The Pollak-Virág telegraph will send 100,000 words over a long wire in one hour. This is over 1600 words per minute. A column of the *Times* newspaper contains a little over 2000 words. A page of this magazine, without pictures, is about 1000 words. So this wonderful telegraph apparatus could send nearly two pages of this magazine in one minute, and at the same time, print it on another receiving apparatus three or four hundred miles distant.

Some two years ago, Anton Pollak, a native of Szentes, in Central Hungary, brought to the United Electrical Company, of Buda Pesth, this untried system of telegraphing at a high speed. The firm, after some deliberation, set up a special laboratory for the purpose of carrying out experiments, and secured the co-operation of the well-known physicist and mechanician, Josef Virág. The results of the experiments on an artificial wire were so satisfactory that it was decided to test the apparatus on a real working wire. By an arrangement with the State telegraph officials, four wires were connected with the laboratory of the Electrical Company from the Central Telegraph Office at Buda Pesth. These wires were in turn connected from the Central Telegraph Office to Temesvár, a town about 200 miles away. The ends of the wires at Temesvár were joined together, and so, although both the sending and receiving apparatus were in the laboratory at Buda Pesth, the messages actually passed over a wire of over 400 miles in length. In order to test every condition the experiments were tried first in fine dry weather and then in wet weather. Copper wires were at one time used, at others iron wires. The best results came from the use of copper wires, but the results were always good. Over this wire of 400 miles in length, passing through open country, messages were transmitted at the speed of 100,000 words per hour. Even then the speed of the apparatus was not at maximum.

The fame of the apparatus having reached America, Messrs. Pollak and Virág were invited to carry out some experiments for the Western Union Company, and these trials were attended with the most satisfactory and even surprising results. In all cases the ordinary working lines were used, and not only was the high speed of the Hungarian experiments equalled, but in one notable instance, over a wire from Chicago to Milwaukee, the phenomenal speed of 155,000 words per hour was attained. In very stormy and wet weather a trial was made over the one thousand miles separating New York from Chicago. Despite the unpropitious conditions prevailing a speed of 65,000 words per hour was attained and maintained. The inventors express themselves more than satisfied with this demonstration of the practical commercial value of their invention.

What is the marvellous apparatus which produces this result? It is an ingenious combination of the telegraph, the telephone, and photography. In order to understand this extraordinary combination, which, like all great inventions, is fundamentally simple, we must know something of two electrical principles.

First and most important comes the battery. The battery is the generator and source of the electric current. A battery is merely two plates of dissimilar metal immersed in a bath of some chemical mixture—the most common metals used being zinc and copper. In order that a current may flow there must be a complete path for it from the copper back to the zinc. It is possible to bury the wire which goes from one end, or pole, of the battery in the earth, and if the end of the other wire which may be hundreds of miles away, be also buried in the earth the current will find its way back. Now if we had a battery with the zinc end wire buried in the earth, and the copper end wire joined to another wire, which, some miles away, was buried in the earth, a current would flow along the wire from the battery, into the earth and back again, *viâ* the other buried wire. If we turned the battery round and joined the copper end to the buried wire, and the zinc end to the wire which went to the distant station before it was buried, we should have a current flowing in the reverse direction, viz., into the earth, away to the distant buried end of the trunk wire, and back to the battery by way of the trunk wire. This is the first principle we must understand: that the direction of the flow of a current in a wire can be reversed by reversing the connections of the battery.

We must also be familiar with the action of the current on a magnet. If we wind a piece of wire round an iron nail and send a current of electricity through the wire the nail becomes a magnet, with all the powers of a magnet to attract and repel. When the current is stopped the nail ceases to be a magnet. When the current is reversed the poles of the magnet are also reversed. If, however, we use an ordinary permanent magnet instead of a piece of iron, we shall get the following effect. Suppose we have a wire wound round the north pole of a magnet, and pass through the wire an electric current in the direction which would make it a north pole magnet if it were a plain piece of iron. The result is that the strength and attractive power is increased. Now suppose we reverse the direction of the electric current, sending it in the direction which would make a south pole magnet if we were dealing with a plain piece of iron. The effect is to lessen or entirely counteract the attractive power of the permanent magnet. This is the other principle we must understand—a current of electricity passed through a wire wound round a permanent magnet will increase or decrease its attractive power according to the direction of the current.

The apparatus by which the messages are sent is really a device for changing the direction of the flow of the electric current in the wire. The messages are first prepared on a perforated paper ribbon, which has two rows of perforations. (Fig. 1.) The upper row

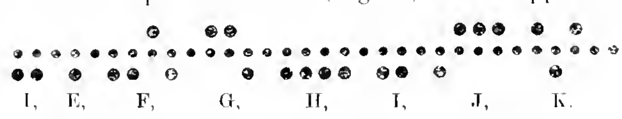


Fig. 1.—Photograph of the perforations in the sending slip of the Pollak-Virág Telegraph. The central line of perforations are for guiding purposes.

corresponds to the "dashes" of the Morse alphabet, the lower row to the "dots." This ribbon is then passed over a metal cylinder (Fig. 2) connected with the wire which goes to the distant station. On the top of the ribbon two little metal brushes press, one of which is connected with the copper pole of the battery, and the other with the zinc pole. When a perforation in the paper ribbon passes under one of the brushes, the brush touches the metal cylinder beneath, and a current is sent. If one of the top row of holes passes, the brush which is joined to the copper end of the battery touches the cylinder, and a current flows along the wire to the distant station, and back, through the earth, to the zinc end of the battery. If one of the lower row of holes passes, the brush which is connected with the zinc end of the battery touches the cylinder, and a current flows in the opposite direction, viz., through the earth to the distant station, and back, through the trunk wire, to the battery. The holes in the paper are so arranged that only one brush can touch the cylinder at one time. So according to the arrangement of the

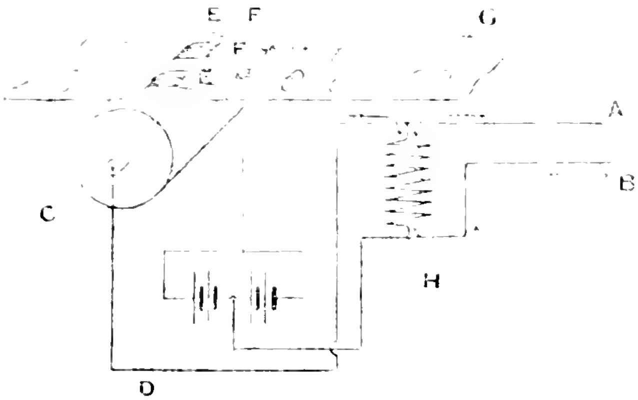


Fig. 2.—Diagram of the sending apparatus of the Pollak-Virag Telegraph. A. Trunk or line wire; B. Earth or return wire; C. Metal cylinder; D. Battery; E. Positive electrode or brush; F. Negative electrode or brush; G. Perforated sending slip; H. Self-induction Coil for neutralising inductive disturbances on line.

holes on the paper ribbon, we have currents sent to the far-away office which sometimes flow in one direction and sometimes in the other. A large number of clerks prepare the paper ribbons, and the sending apparatus can be fed at the pace required. This is extremely simple and easily followed in the illustration.

Now as to the receiving arrangements. These consist, first, of a fairly powerful bar-magnet fixed in a kind of box having one side composed of thin metal, or ferrotype. The magnet is fixed in such a manner that it draws in the metal side to a slight degree. Round that part of the magnet which is near the metal side, or diaphragm, of the box, is fixed a coil of fine wire. The

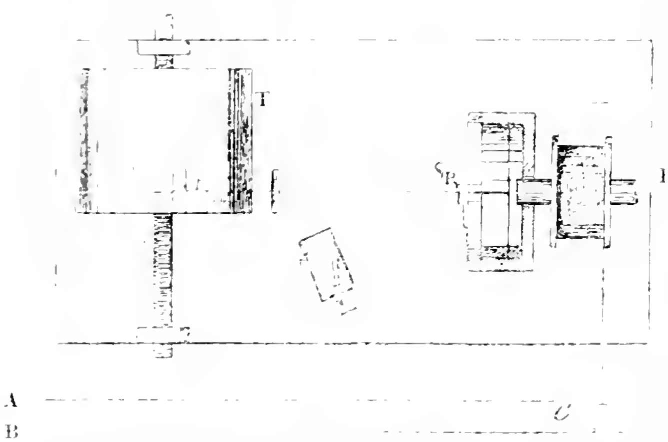


Fig. 3.—Diagram of the receiving apparatus of the Pollak-Virag Telegraph. A. Trunk or line wire; B. Earth or return wire; C. Condenser for neutralising disturbances due to the "Capacity" of the line; D. Coil; Sp. Mirror; L. Electric glow lamp; T. Drum of sensitized paper.

disposition of these parts can be easily distinguished in Fig. 3. Remembering what has been said above about the effect of an electric current on a magnet, we can see what would be the result of a current passed through the coil of wire fixed on the end of this magnet. The end of the magnet near the diaphragm is a north pole. The wire on the coil is wound in such a way that when the current flows from A to B the power is increased whilst when it flows from B to A the power is decreased. The result of increasing the power of the magnet is to draw the metal diaphragm nearer, whilst if the power is decreased, the diaphragm is released, and draws away from the magnet. With the sending apparatus previously described the current is sent sometimes in one direction and sometimes in the other. The diaphragm answers to this change in the direction of the current by swerving towards or away from the magnet. But at the pace of 100,000 words per hour, the diaphragm would move 26,400 times per minute. So some means had to be devised to register these movements in an intelligible way. This is done by enlisting the aid of photography in the following ingenious way.

In front of the diaphragm is fixed a large magnet made in a peculiar manner. It is curled round somewhat like a horse-shoe. One end of it is cut into two points, the other end into a pointed weak spring. A tiny mirror (Fig. 3, Sp) with a small plate of iron fastened to its back is suspended to the two pointed end, which holds it by magnetic attraction. The spring end of the

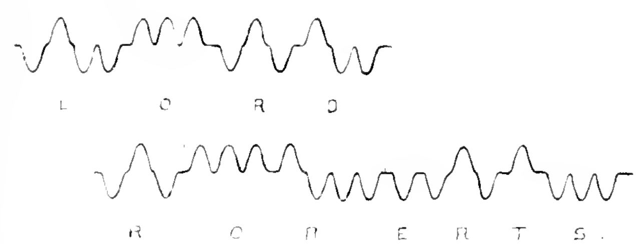


Fig. 4.—The words "Lord Roberts" as they would appear when written in the Morse code by the Pollak-Virág Telegraph.

magnet touches another tiny iron plate on the back of the mirror. A very small light metal rod is fixed to the middle of the diaphragm, and to the spring end of the magnet. Now if the diaphragm moves, this rod communicates the movement to the spring, which in turn moves the mirror. The two-pointed end of the magnet acts as a sort of hinge with practically no friction, upon which the mirror swings.

Some little distance from the mirror, a small electric glow-lamp is placed, which throws a light on to the reflecting surface. This light is reflected on to a drum covered by sensitized paper. These details can be easily followed in Fig. 3.

When the diaphragm is drawn inwards the lower end of the mirror is drawn back and the light ray is depressed. When the diaphragm moves away from the bar-magnet the lower end of the mirror is thrust forward and the light ray is raised. This results in a line on the sensitized paper, which rises sometimes in waves above the central line, and is sometimes depressed in waves below the central line. The waves above the line represent the "dashes" of the Morse alphabet, those below represent the dots. In Fig. 4 the words "Lord Roberts" are given as they would be indicated by these waves. After the message has been sent, the sensitized paper is taken from the drum and the marks are "fixed," a process occupying about two minutes, and then the message is ready to be written up by a clerk.*

* Herr Pollak writes to me as follows:—"We are now using endless slips and diagonal writing combined with an automatic system of development, so that messages are ready for transcription immediately on receipt."

These are the arrangements by which this marvellous rapidity of telegraphing is carried out. There were many technical difficulties in the way of its realization, but these have all been overcome by the same ingenious methods applied to the details, and one of our illustrations (Fig. 5) is an actual reproduction of a message received at the rate of over 1600 words a minute on a wire some 404 miles in length. The possibilities of this system seem almost infinite. In cases where the number

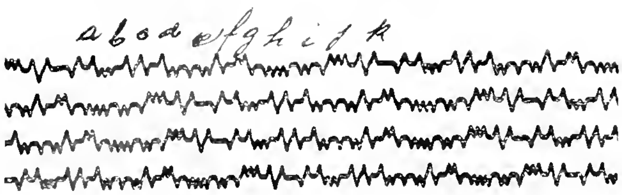


FIG. 5.—Photographic reproduction of an actual message written by the Pollak-Virág Telegraph at the rate of 100,000 words per hour. The message consists of the letters of the alphabet A—K repeated continuously.

of wires is limited, such as in a long submarine cable, the carrying power is multiplied in an astounding manner. Fancy being able to send a column of this magazine, about 500 words, to America in twenty-two seconds. Take an ordinary newspaper of 40,000 words, for example. It would pass over the wire by this system in twenty-five minutes, whilst on the Wheatstone system it would occupy one hour and forty minutes. With a Morse sounder working as rapidly as the fastest operators could work it would occupy nearly fifteen hours. A message of 500 words occupies about 30 yards of slip by the Morse system. The same message by the Pollak-Virág system barely covers a piece of paper measuring 5 feet by 10 inches.

THE PYGMIES OF ASIA.

By R. LYDEKKER.

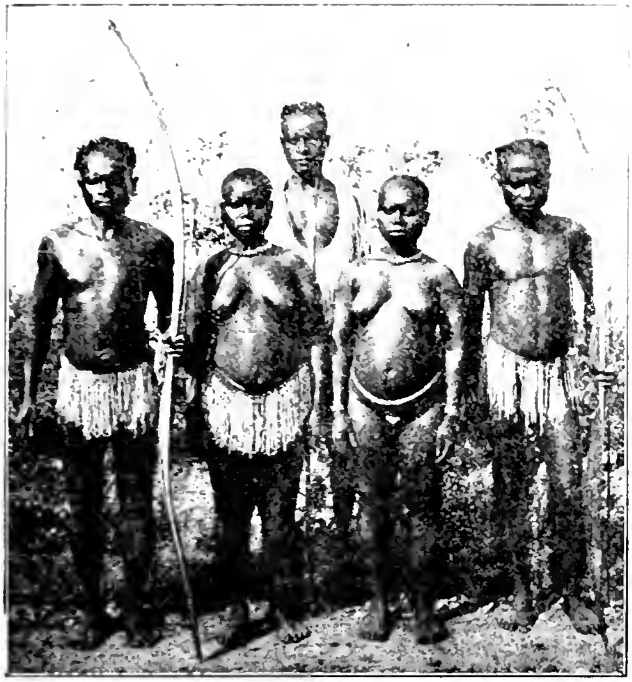
So recently as the year 1858, when they were selected as a convict settlement by the Government of India, the group of islands in the Bay of Bengal known as the Andamans were practically cut off from the rest of the world; and no definite knowledge was extant in Europe as to the peculiarities of the natives by whom they were inhabited. It is true that the existence of such aborigines had been ascertained long before, Arabic writers of the ninth century having referred to them, while they were also mentioned at a later date by the Venetian traveller, Marco Polo. Moreover, so far back as the year 1788, the East India Company attempted to form a penal station on these islands, which was, however, abandoned a few years later without any accurate information having been obtained with regard to the affinities and characteristics of their aboriginal inhabitants. This lack of information with regard to the natives appears to have been largely due to the reputation they had gained for ferociousness and hostility to strangers, in consequence of which they were avoided as much as possible by the officials sent to establish the proposed settlement. To a certain extent this was a fortunate circumstance, as it prevented the native race from being contaminated by foreign admixture until a much later period, when competent observers were fortunately among those stationed by Government on the islands.

A glance at the map of Asia will show that the Andamans have their longer diameter running nearly due north and south, and that they form the central and main portion of a curved chain of islands commencing off Cape Negrais—the southern extremity of Aracan—and terminating in the Nicobars; and it seems highly probable that this chain originally formed a peninsula, with its axis running parallel to that of Tenasserim. The southernmost island of the group is the imperfectly known Little Andaman, while the other three main islands, which are separated from one another by narrow channels, and are respectively named North, Middle, and South Andaman, collectively constitute Great Andaman. The total length of the latter is 140 miles, with a maximum breadth of 20 miles.

To the anthropologist these islands are of surpassing interest from the circumstance that their native inhabitants are the purest representatives of a race of diminutive round-headed, Negro-like people, peculiar to South-eastern Asia, and definitely known elsewhere only in the Malay Peninsula and the Philippine Islands. Even in the Nicobars these Negritos, as they are called, are quite unknown, the natives being more or less closely connected with the Malays. By the older writers the aborigines of the Andamans were universally called "Mincopies," but as there is no clue to its origin, this term, which is unknown among the natives themselves, has now given place to the appellation Andamanese.

Although having the characteristic frizzly, or "woolly," black hair of Negroes, and also agreeing with that type of mankind in the relative proportions of the limb-bones (especially the shortness of the humerus, or upper arm-bone, as compared with the bones of the fore-arm), as well as in the form of the pelvis and the large size of the teeth, yet the Andamanese do not show the characteristic Negro features in their full development. The jaws, for instance, are less projecting, the lips thinner and not so prominent, and the nose narrower and less flattened; so that the coarser features of the Negro type may be said to be softened or "toned" down to a remarkable degree. Whether the Andamanese or the Negro type is the more primitive may be left an open question. A further important point of difference from African Negroes is to be found in the shape of the skull, which is of the round instead of the long and narrow type; the relative breadth is, however, by no means so great as in certain other round-headed races. As regards height, the Andamanese present a very marked contrast to Negroes, some of whom, like the Zulus, are very tall. According to Mr. E. H. Mann (formerly assistant superintendent of the islands), the average height of the men is only 4 feet $10\frac{3}{4}$ inches, and that of the women 4 feet $7\frac{1}{4}$ inches; the tallest man measured by that observer being 5 feet $4\frac{1}{2}$ inches, and the shortest woman 4 feet 4 inches.

The skin does not appear to be absolutely black; but there is some degree of discrepancy in this respect between the accounts given by different observers. The late Professor V. Ball, who visited the Andamans in 1873, states that the colour of the skin is generally obscured by the red clay, grease, or wood-ashes, with which the Andamanese are in the habit of anointing themselves, and that its real tint is only revealed among the well-washed orphans at Port Blair. In fact, the more an Andaman islander washes himself the blacker he becomes! The hair of the Andamanese, like that of other Negritos, is disposed evenly over the scalp in close spirals, and not in the separate tufts, with intervening bare spaces, characteristic of the Bushman type. While generally black, it may sometimes be very dark brown in colour. In some instances the hair is allowed to grow to its full length, but it is very frequently (as in the accompanying illustration) partially or completely



Group of Andamanese at the Calcutta International Exhibition, 1883-84.
Photographed by Colonel Waterhouse.

shaved. Professor Ball mentions meeting a large party of Andamanese none of whom possessed a hair on any part of their bodies. In mourning the head is invariably shaved.

Previous to the founding of the European settlement at Port Blair, in the neighbourhood of which certain regulations are now enforced with regard to clothing (as in our illustration), the Andamanese were in the habit of going about in a perfectly nude condition, save that the women wore a leaf suspended from a girdle made of the fibres of rattan or the screw-pine. This absence of dress is probably to some extent due to the nature of the Andaman climate, which renders it unnecessary to keep the body warm by artificial means. With the exception of a small, and probably introduced, race of wild pigs (whose flesh afforded an important food supply), the islands are inhabited by no animals larger than palm-civets, and even of these the natives never learnt the art of dressing the skins. Neither did they practise agriculture nor attempt to domesticate the indigenous pigs and jungle fowl, but lived entirely by hunting and fishing, and on such edible roots, fruits, and berries as grow naturally in the jungle. In addition to pork, their animal food included the flesh of palm-civets, dugongs, monitor lizards, turtles, and occasionally porpoises, together with turtles' eggs, fish of various descriptions, prawns, shell-fish, and even the larvæ of large wood-boring and burrowing beetles. The hostility displayed to strangers (apparently largely due to kidnapping raids on the part of Chinese and Malays) not improbably gave rise to the statement that the Andamanese were cannibals; but this charge has been completely disproved.

Both sexes were thoroughly at home in the water from an extremely early age, and the creeks and straits of the island were navigated in dug-out canoes and outriggers of home manufacture. Home-made clay pots, either partially baked by fire or dried in the sun, formed their domestic utensils; and for capturing game and fish they employed bows and arrows, spears, harpoons, and nets. With the latter, says Mr. Mann, they take fish more readily than the most skilful angler. In modern times their spears and arrows have been tipped with bone or shell, but in the old refuse heaps of the islands polished arrow-heads and adzes of stone have been discovered, evidently manufactured by the forefathers of the present aborigines. And it has been suggested that the use of stone has been superseded by shell and bone owing to the greater facilities with which the two latter substances are worked. Till within a comparatively recent time chips or flakes of flint were, however, still used for shaving, although these have now been completely superseded by glass. Professor Ball relates how he witnessed the manufacture of such glass flakes by a woman who chipped them off from a piece of dark bottle-glass with a pebble. "Having struck off a flake of suitable character," he writes, "she forthwith proceeded, with astonishing rapidity, to shave off the spiral twists of hair which covered the head of her son." But even at this date (1873) the writer was informed that the art of making flint-flakes was entirely lost; the process of flaking being facilitated by first heating the stones in a fire. Serviceable knives were manufactured from a large bivalve shell to be met with in numbers on the shores of the islands.

The mention of fire affords an opportunity of referring to the extraordinary circumstance that although the Andamanese were well acquainted with its use (always eating their meat and fish in a more or less cooked condition), yet they were totally unacquainted with any method of producing it. According to the legend, fire was originally obtained from a volcano in Barren Island, situated to the eastward of the Middle Andaman; and it was ever since kept going by maintaining a constant supply of smouldering or burning wood.

In addition to strings of shells, the women wear the skulls of deceased relatives as ornaments. Red clay is employed for daubing the skin; but during periods of mourning, when the head is shaved, this is replaced by a uniform coating of white clay. Allusion has been already made to the girdles and fishing-nets of vegetable fibre, and the latter is also employed in the manufacture of baskets and sleeping mats. As an amusement, the men are fond of making "cat's cradle" with pieces of string, and as the same game is practised by the Dyaks of Borneo and other Malay tribes, it was probably imported into the Andamans from the East, as it can scarcely be regarded as a survival from the original Negrito population of the Malay Peninsula. The dwellings of the Andamanese are of a rude and primitive type, but these are not all alike, the most simple being mere shelters of leaves and boughs, which are usually erected only in temporary encampments and not in the permanent villages.

Although subject to passionate outbursts of temper, during which arrows may be shot recklessly among friends and relations, the Andamanese are described by all who have known them well as singularly amiable and kind in their mutual relations; and in many respects they resemble the Melanesians, being merry, talkative, inquisitive, restless, prone to resent an injury, but fond of a joke so long as it does not assume a practical form. From the majority of savage peoples they stand out in pleasing contrast on account of the treatment accorded to the women by their husbands. A man has but one wife, to whom he is nearly always faithful throughout life, and whom he regards as an equal, and treats with an affection which might be copied by some civilised people. Like many savage races, the Andamanese have evolved a complicated system of marriage prohibitions between relatives, and they have likewise regulations as to the particular kind of food they may or may not eat at certain seasons of the year, as well as superstitions with regard to uttering certain words or names. But to mention these and many others of their customs would exceed the limits of my space. There appears to be no form of recognised worship, yet there is a vague belief in a supernatural being (*Puluga*), whose dwelling-place is in the sky, and who created all living creatures with the exception of a few evil spirits whom he is unable to control. Thunder is supposed to be a manifestation of the wrath of this supreme being, who is credited with the curious incapacity of being unable to understand human thoughts during the hours of darkness, although he is capable of so doing during daylight. The absence of any traditions among the Andamanese of the arrival of their forefathers from some other part of the globe may be taken as confirmatory of the physical evidence as to their long tenure of their present home. By the aborigines the Andaman Islands are indeed regarded as alone constituting the world; and the few strangers by whom they were visited in the early days of their history were looked upon as their own departed ancestors. The islands themselves are believed to be supported on a lofty tree, one day destined to be overthrown by an earthquake, when they will be re-occupied by the deceased predecessors of the present inhabitants.

As regards arithmetical power the Andamanese stand on an exceedingly low platform, as they have only words for one and two. If they desire to express a higher number, some word indicating several or many is usually employed, but even then about six or seven seems to form the limits of their arithmetic. A few specially gifted individuals are, indeed, able to indicate ten by tapping the nose successively with the ten fingers and then holding up the two hands, but beyond this none are able to go.

In spite of this exceedingly low development of calculating power, the Andamanese have succeeded in evolving a remarkably complex language, of which each of the nine tribes possesses a dialect of its own. Into the characters of this language it is impossible to enter on the present occasion, but it may be mentioned that it appears to have no close affinity with any other known tongue, and consequently sheds no light on the origin and relationship of the race by whom it is spoken.

In spite of every care exercised by those in authority, the establishment of the convict settlement at Port Blair has produced the results universally observed when a primitive and long isolated people are first brought into contact with higher races. The newly introduced habits, diseases, and vices soon told with fearful effect on the aborigines; the pure-blooded race showing a marked tendency to die out and to be replaced by half-breeds. In 1891 the number of pure-bred Andamanese was stated to be less than 4000, and there is little doubt that their eventual fate, like that which has already befallen the Tasmanians, is complete extermination.

If we now enquire as to who are the nearest relatives of the Andamanese, and whence they came, we shall be confronted with a considerable amount of difference of opinion on the part of those who have paid most attention to the subject. By some it has been supposed that a Negrito population is to be met with in the more remote hill districts of India, China, and all the Malay countries, as well as in New Guinea, and that these presumed Negritos indicate the original population of South-eastern Asia before the time that it was overrun by Mongolo-Malayan tribes. And it has been further considered that there is no intimate relationship between the true Negritos of the Andamans and the long-headed Oceanic Negroes of Papua and Melanesia.

These views have, however, been recently opposed by Dr. A. B. Meyer, the learned Director of the Dresden Museum, who attaches comparatively little importance to round heads and long heads, and is of opinion that, in addition to the Andamanese, and apart from Papua, the only Negritos definitely known to exist in Asia are confined to the Malay Peninsula and the Philippine Islands. Moreover, according to the same authority, Negritos, in place of having no near kinship with the long-headed Papuans and Melanesians, are their very intimate relations, there being no evidence to support the view that the round-headed individuals occasionally met with among the two latter indicate the remnants of a distinct Negrito race.

If these opinions represent the true state of the case, and if, as has been suggested in previous articles of the present series, the Australian aborigines and the primitive tribes of India and Ceylon are related to the Caucasian rather than to the Negro type, it will be evident that the Negro element occupies a much less important position in South-eastern Asia than has been commonly supposed. Unfortunately, however, no definite light is thrown on the problem whether the birthplace of the Negro stock should be sought in Africa or in Asia.

Putting aside such theoretical questions, the short remaining space may be devoted to the nearest living relatives of the Andamanese. The existence of Negroes of small stature in the Philippines appears to have been known to the Chinese at the commencement of the thirteenth century, and the name Hai-tan was applied by them to the people in question. These small, black, frizzly-haired people were subsequently encountered by the Spaniards when they colonized the Philippines, and as they were first seen in the mountains of Luzon, they received from their conquerors the title *Negritos del Monte*. They are accordingly the typical "Negritos." Their native name is Aita, Ita, or Inagta, which means black, being akin to the Malay *itam;* and it is possible that the Chinese designation *Hai-tan* may have a similar meaning. The average height of the men is 4 feet $8\frac{3}{4}$ inches, and that of the women 4 feet $6\frac{1}{2}$ inches. Not only in physical appearance, but likewise in several of their moral characteristics, these little Negroes resemble the Andamanese, and it is a highly significant fact that they are likewise faithful to their marriage vows and have but one wife each. Negritos are likewise also found in other islands of the Philippine group, such as Mindoro, Panay, Negros, Mindanao, etc.; but our information concerning all of them is extremely deficient. The only other region where Asiatic pygmies are known to occur is the Malay Peninsula; but our lack of knowledge of them in that area is, if possible, even more conspicuous than in the Philippines.

ASTRONOMY WITHOUT A TELESCOPE.

By E. Walter Maunder, F.R.A.S.

VIII.—FOUR VARIABLE STARS.

It is 304 years since David Fabricius, one of the earliest observers of sun-spots, noticed that a star in the neck of Cetus the Whale, which he had observed in August, 1596, to be of the 3rd magnitude, had disappeared by October. This appeared an observation of great importance, since it seemed to show that the fixed stars are not all of them permanent, but that they might die out. Seven years later Bayer recorded a 4th magnitude star in precisely the same position as that which Fabricius had noted to have disappeared. Here, however, the matter rested for an entire generation, and it was not until 1638 that Holwarda detected the star again as of the 3rd magnitude in December, but found it disappear in the following summer to reappear again in the autumn. This star, therefore, Omicron Ceti, which received from Helvelius the name of Mira, the wonderful star, was the first to become known as a periodic variable.

The first star, that is to say, in historic times. There is another, more striking even than Mira, which it seems likely was noted by the forgotten astronomers of Arabia or the valley of the Euphrates centuries before even Hipparchus and Ptolemy compiled their catalogues. This is Beta in the constellation Perseus, described by Ptolemy as the principal star in the head of the Gorgon Medusa, which the hero is represented as carrying in his hand. This star has come down to us from the Arabs with the name Algol, the Demon Star, and it is at least a probability that it owed this name to the fact that though ordinarily of the 2nd magnitude it sinks down almost to the 4th at perfectly regular intervals of two days and twenty-one hours.

The variability of Algol was discovered in modern times by Montanari in 1669, and it was re-discovered by Goodricke in 1782. The latter observer two years later added two other variables to the list; Beta Lyræ with a period of very nearly thirteen days, and Delta Cephei, with one of five and a-third days. At this date scarcely more than a century ago these four stars were almost the only variables known to us, and variables continued to be rare objects until the middle of this century. Now their numbers have been added to so greatly that the catalogue prepared by Prof. Chandler in 1896 comprises 400, the variability of which is fairly well established, and new members of the class are being discovered every month.

These four stars are all well in view during the September nights. Delta Cephei being a circumpolar is necessarily always visible, and is now overhead at midnight; Algol also is a circumpolar, but descends too near to the northern horizon at its sub-polar transit for observation then. At midnight on September 1, however, it is high up and almost due east of the observer, whilst Beta Lyræ is at a similarly favourable elevation in the west. Mira Ceti being slightly south of the equator is only above the horizon about 11½ hours out of the 24; it comes to the meridian at midnight towards the end of October, consequently at midnight on September 1 it is low down in the south-east.

Mira Ceti has been somewhat irregular in its period of late, but should have just passed a maximum. Its brightness at maximum varies through wide limits; sometimes it scarcely exceeds the 5th magnitude, sometimes it is distinctly brighter than the 2nd, but usually it ranks between the 3rd and the 4th. It is thus always within the range of unassisted sight at maximum, but it goes down far below that range at minimum, its faintest light bringing it down practically to the 10th magnitude. The "astronomer without a telescope," therefore, can only watch it at its maxima, but these form for Mira Ceti the interesting phase. The other three stars are at all times well within the range of vision. A telescope, therefore, is not needed for them, and it is much better that it should not be used.

The most striking star of the four with which to begin is Algol. The student, avoiding all references to Ephemerides, should look out at regular intervals and compare the brightness of Algol with certain of the neighbouring stars. Ordinarily Alpha Persei will be distinctly but not very greatly brighter than our variable, whilst Gamma, Delta, Espilon and Zeta will be distinctly fainter. At a little greater distance are Alpha and Beta Arietis, the former slightly brighter, the latter slightly fainter than Algol. Alpha and Beta Trianguli are at no great distance, and are good comparison stars when Algol has begun to fade.

It will not be long before the observer will find that his star is undergoing a change, and that it no longer nearly rivals Alpha Persei or Gamma Andromedæ in brightness. Directly this is noticed, systematic observation should be commenced. A star should be chosen, reasonably near, distinctly brighter than the variable, and a second star distinctly fainter. It is usual among variable star observers to estimate these differences in "steps," these "steps" corresponding generally to about a tenth of magnitude, though probably the beginner will make his steps considerably larger than this. The central principle, however, is that two stars should be selected, one of which the observer is clear to be fainter than the variable, and the other brighter, and yet both of them pretty near the variable in brightness. The student should further be careful to record whether the difference between the variable and the fainter star was equal to, greater than or less than the difference between it and the brighter. An observation therefore might run as follows:—

Sep. 1d. 11h. 15m. $2 > a$ $3 < b$

where a and b are the two comparison stars. This would mean that at 11h. 15m. the variable was noted to be two "steps" brighter than a and three "steps" fainter than b; in other words that it is slightly nearer an equality with a than with b.

Of course there is no reason why the observer should confine himself to two comparison stars. To begin with, indeed, it is well that he should try more; bearing in mind that the stars should be as nearly as possible at the same altitude, as a marked difference in the height above the horizon will have a considerable effect upon the estimation.

Having made one set of satisfactory observations, the student should leave the star for a while—say for half-an-hour—and then make an entirely fresh set of observations. If he should be fortunate enough to hit upon the commencement of a minimum his second observation will show him the star somewhat fainter than the first, and the difference will become more marked at a third observation. The entire period of decline and recovery for Algol is nine hours, the light fading for 4½ hours, remaining constant for a few minutes, and then gradually increasing again for another period of 4½ hours. The light changes therefore at a most rapid rate at about 2¼ hours before minimum or about the same interval afterwards, that is to say when the change is about half completed.

The observation is a simple one, with no accessories of brilliant lights or pleasing colours. Yet the young observer cannot, we think, but experience a real pleasure when for the first time his observations, carefully and systematically made and duly recorded show him beyond a doubt that he is witnessing the dimming of the Demon Star; that he is watching across untold millions of millions of miles of space the signalling of that far distant sun. There will be a sense of achievement, greater and not less because it has been accomplished by his unaided sight, than if he had had the help of some great instrument, and if there be in him anything of the stuff of which astronomers are made, he will turn eagerly to look for other objects of study, and will wait with much interest for other opportunities of watching Algol.

He will not soon exhaust this field of work which Algol has to offer him. Minimum after minimum should be carefully watched so as to determine the period. This of course is now known with the utmost exactness, even to the thousandth part of a second, and the purpose of the student's making an independent determination is for his own training in the work, not for a closer approximation to the true elements of the star. Nevertheless it has been by the continual repetition of such observations, long after the period was precisely known, that minute variations in it have been discovered, and the student should certainly not drop Algol from his observing list until he has been able not only to work out a period for himself, and so to predict in advance future minima, but also to detect an apparent irregularity in the period which is known as "the equation of light," and which is due to the fact that light takes some 16 minutes to cross the orbit of the earth. Minima which are observed in November, therefore, when the earth is at its nearest position to Algol, come earlier than the average; those in March and June come later.

It is of course well known now that the variability of Algol is due to its having a dark companion which revolves round it in about 69 hours. The variation in Beta Lyræ is of a more complicated kind. Here there are two minima, one less pronounced than the other, and we infer therefore that in this case both stars are bright and that they alternately eclipse each other. The variation is less than with Algol, being but little more than a single magnitude.

Delta Cephei has a variation of much the same amount as Beta Lyræ, but it differs from that star in that it has a slow decline and a quick recovery—the decline being 91 hours, the recovery 38.

It is, however, rather with the variables of longer period that the student will most occupy himself, and, therefore, it is especially desirable that the beginner should turn his attention to the last of the four stars which I have named, Mira Ceti, before it again fades into invisibility.

JUPITER AND HIS MARKINGS.

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

Jupiter is the most interesting planet of the solar system, considered as a subject for telescopic investigation; and he is certainly one of the easiest objects we have, on account of his large size and the conspicuous character of many of the markings he displays. It is in the study of changes in the figure and motion of these markings that Jupiter offers attractions of a more distinct and special kind than those of any other planet. Venus is beautiful, as a crescent, but her disc shows no more than mere suspicions of dusky areas, of which it is exceedingly difficult to trace the outlines or discern variation. Mars displays an interesting configuration, in reference to which we have still much to learn, but he is of small dimensions, and only visible to the best advantage at comparatively long intervals. Saturn exhibits a novel and picturesque effect, but his details are somewhat faint, and this, combined with his great distance and relatively small apparent diameter, has occasioned a good many dubious observations of late years. No doubt there are occasional irregularities in the belts, and definite spots now and then appear, for there is every reason to believe that the surface phenomena of the planet is somewhat similar to that operating on Jupiter.

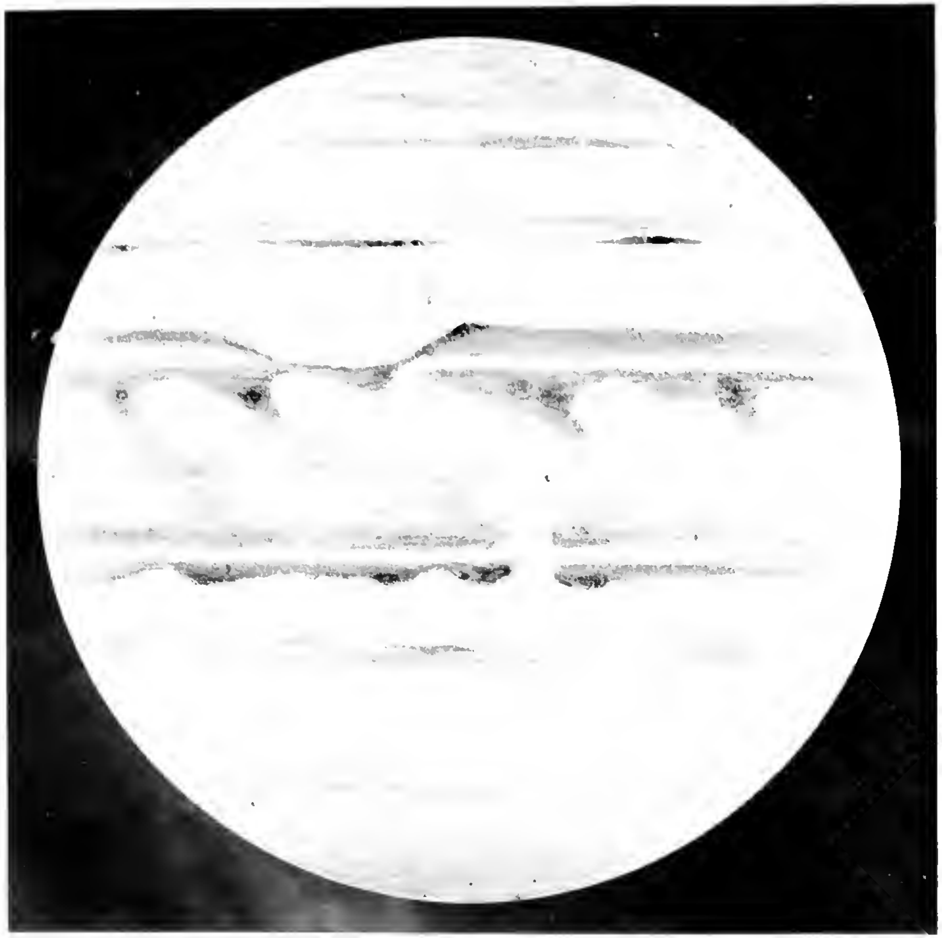
In 1878 and 1879, when the great red spot developed into striking prominence and became an attractive object for study, the planet Jupiter was surveyed in nearly every telescope, and our knowledge of his phenomena was much enhanced. It was soon found that the dark belts and bright zones represented a series of different longitudinal currents. The red spot indicated a rotation in 9h. 55m. 34s., the white equatorial spots in about 9h. 50m., while in 1880, some dark spots in the north hemisphere returned in 9h. 48m. Other objects showed proper motions, and the rates seemed to vary with the time. It is true these features were not entirely new, for Cassini, about two centuries before, had seen a white equatorial marking rotating in 9h. 50m., while a great southern spot (possibly identical with the red spot of our own times) moved in 9h. 55m. 58s.

The spots having considerable proper motion and being subject to extensive changes cannot be regarded as material parts of the planet's surface. They are probably situated in the outer envelopes of Jupiter, and do not accurately indicate the true rotation period of the planet's globe. It is probable that the time differs little from 9h. 56m., but it is doubtful to several seconds In the case of Mars we know the rotation period to the tenth of a second, his principal lineaments being durable surface markings, which have been followed during the two and a half centuries which have elapsed since the times of Huygens and Hooke.

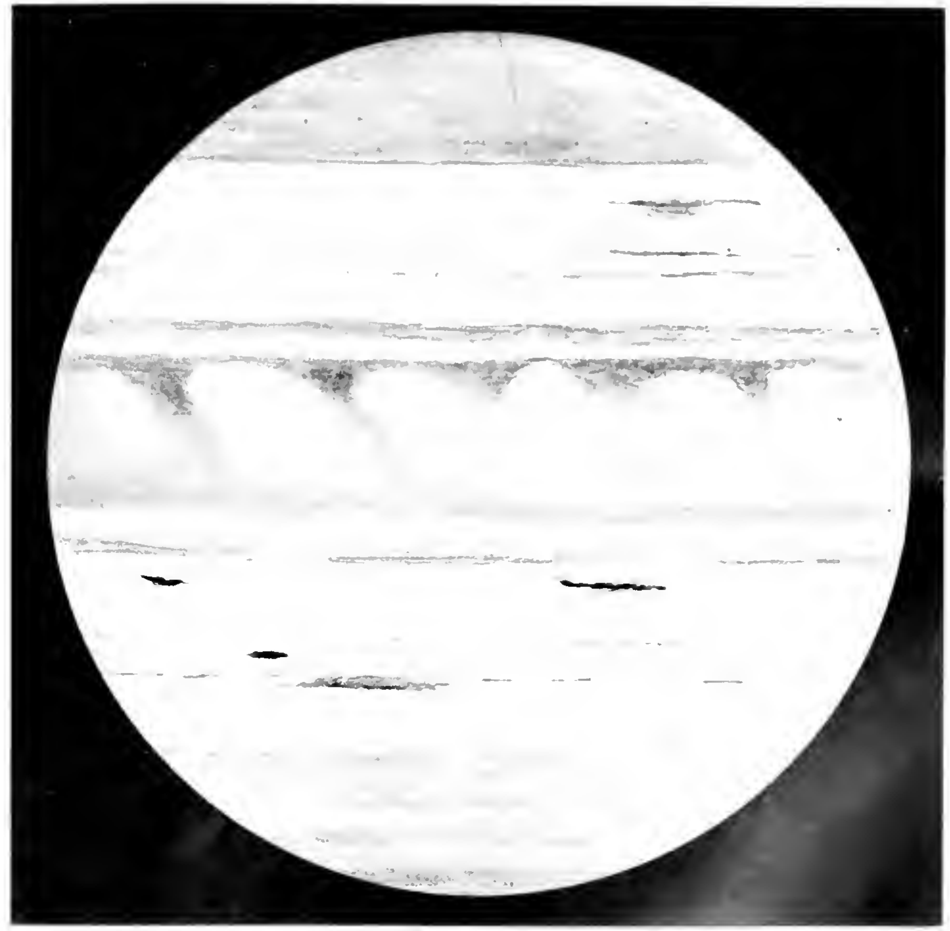
During the last few years Jupiter has received much further investigation. The red spot is still present, though only as a dusky stain in the bay or hollow in the south side of the great southern equatorial belt. The latter feature has certainly been intermittently visible since 1831, September, when Schwabe drew it, and there is every prospect that it will remain visible for many years. In fact, it appears to be an object which, like the red spot, is subject to fluctuations, not only of velocity but of appearance, and is also liable to temporary obliteration. Its mean rate of rotation between 1831, September, and 1899, September, was 9h. 55m. 36.4s. (from 60,074 rotations), while its present rate is about 9h. 55m. 41.7s., but in recent years it has varied as under:—

	h.	m.	s.		h.	m.	s.
1894	9	55	41.0	1897	9	55	41.5
1895	9	55	41.1	1898	9	55	41.6
1896	9	55	41.3	1899	9	55	41.7

The values for the last two years are slightly less than those given in my paper in *Monthly Notices*, Vol. LIX., p. 580, and they are more correct, depending as they



Jupiter.—1899, August 1, about 7h. 50m. 10-in. Reflector, power 312. W.F.D.



Jupiter.—1898, April 22, about 8h. 30m. 10-in. Reflector, power 312. W.F.D.

JUPITER AND HIS MARKINGS.

do upon a later and more complete investigation. There are indications that the spot has now begun to show an accelerated rate, my recent observations being as follows:—

Date. 1899	Transit. h. m.	Longitude °	Date. 1900	Transit h. m.	Longitude
Aug. 30	6 33	57.0	Jan. 8	20 22	56.4
Sept. 6	7 21	56.4	Feb. 6	19 26	57.9
" 14	5 59	54.7	" 20	20 59	57.4
" 15	5 41	56.5	" 21	16 55	59.0
Dec. 13	13 51	58.2	Mar. 15	15 5	58.7
" 30	17 54	55.7	" 17	16 42½	59.5

From thirty-five transits obtained in 1899, and from others secured in 1898, I found that the longitude of the spot was increasing at the rate of 0°.7 per month and that if this had been continued the marking would now be in 41°.5, whereas its position is about 40°, so that its rotation period this year has very slightly exceeded the rate (9h. 55m. 40.63s.) adopted for system II. of Mr. Crommelin's Ephemerides, published in *Monthly Notices*. The spot now follows the zero meridian about 66 minutes. Its eastern (following) end is darkest, and easily seen, but the entire elliptical outline of the object can only be traced on a really first class night.

There are a large number of equatorial spots visible in the form of irregular white and dark patches which are constantly undergoing changes. In the various years when I have watched such of these markings as border the south side of the Equator, their rotation periods have been as under:—

	h. m. s.		h. m. s.
1880	9 50 5.8	1886	9 50 22.8
1881	9 50 8.8	1895	9 50 34.3
1882	9 50 11.4	1898	9 50 23.6
1885	9 50 14.3	1899	9 50 24.6

The present period of these objects does not differ materially from the rate exhibited in the two preceding years. I believe that many of these objects have existed for a very lengthy interval. They are probably the same objects as were seen so prominently in 1879, 1880, and following years. Or we may go back further still to the similar appearances figured by Gledhill and others in 1869 and 1870, and even to the equatorial spots delineated by Dawes, Huggins, Lassell, and others, in 1858 and 1859. But there is a difficulty in identifying the objects, as they are very numerous, and a break of a few months has necessarily to occur in the observations every year, Jupiter being invisible near to the sun. At the present time, though the mean rate of the equatorial current is about 9h. 50m. 25s., the individual spots differ in their rates from about 9h. 50m. 15s. to 9h. 50m. 35s.

In the south temperate zone (in which the red spot lies) the spots rotate at a regular rate of 9h. 55m. 19s. I have noticed no change whatever in their motion during the last twenty years, and, consulting old records, I find that they have preserved the same period for a great length of time. This is very curious, in view of the singular variations of rate apparent in other latitudes, and I believe these south temperate markings, like many other features of Jupiter, are of considerable duration. They suffer variations due to the atmospheric vicissitudes under which they exist, but, though temporarily obliterated, reappear in the same positions. There are quite a large number of light and dark spots in about S. latitude 28° or 30°, which have, I believe, been visible during the last twenty years. They move more rapidly than the red spot, and pass that object just on his southern borders. Their conjunctions with the red spot are exceedingly interesting phenomena. In about 1880, when the rotation period of the latter was 9h. 55m. 35s., the conjunctions occurred at intervals of about 920 days, but in about 1898 the period was reduced to 650 days. The interval separating the conjunctions has, however, varied each year in consequence of the marked change of velocity in the rate of the red spot. I have traced back the conjunctions of two south temperate dark spots (nearly all observed) with the red spot approximately as follows:

I.	II.
1881, December	1880, July.
1884, April.	1882, December.
1886, May.	1885, February
1888, April.	1886, November.
1890, February	1888, September.
1891, December.	1890, August.
1893, September.	1892, June.
1895, July.	1894, April May.
1897, April.	1896, February.
1899, January.	1897, November.
*1900, October.	1899, August.
*1902, July.	*1901, May.
	*1903, January

* These are the predicted dates of future conjunctions.

Spot No. I. is at present in longitude 120°, while No. II. is in 203°. There are several other markings of similar character; two of these were in conjunction with the red spot at following times, viz., No. III. 1892, October; 1894, August; 1896, May; 1898, January; 1899, November; and No. IV., 1892, March; 1894, January; 1895, November; 1897, August; 1899, April.

Further south of the south temperate spots the current is more rapid, the rotation period being about 9h. 55m. 7s.

In the north temperate region there is a remarkable diversity in the proper motions of the objects. Here we discover both the shortest and longest periods. In north latitude, about 30°, the spots and condensations in the belts rotate in periods ranging from 9h. 55m. 50s. to 9h. 56m. Yet there is a narrow belt in about latitude 25° N. which in 1880 rotated in 9h. 48m., and in less than 9h. 50m. in 1891. In this belt there appear to be remarkable disturbances at intervals of about ten years. There were outbreaks from it in 1850, 1860, 1870, 1880, and 1890. Some details of these phenomena were described by the writer in the *Monthly Notices* for December, 1898. It is highly probable that another eruption of spots will take place from the same belt at the close of 1900, and be observed when Jupiter becomes a morning star in February, 1901. Telescopic observers should therefore carefully observe the planet at this time with a view to detect the recurrence of the phenomenon.

In the N. tropical zone of Jupiter, and bordering the N. edge of the northern equatorial belt, we find another seat of very active and long continued energy. White and dark spots are plentifully distributed along the edge of the belt, and they do not partake in the rapid velocity of the equatorial current, their period being about 9h. 55m. 33s., though it varies to the extent of a few seconds in different years. In 1899, the individual markings differed in their periods to the extent of 18 seconds, and it was clearly manifested by all the observations that one section of the belt, between longitude 140° and 260°, was moving much more rapidly than the other part (*see* Rev. T. E. R. Phillip's valuable chart in *Monthly Notices*, Vol. LX., p. 214).

The time seems come when all observations of Jupiter made at each opposition of the planet should be com bined and discussed according to approved methods The greater the number of observations the nearer the approach will be to accuracy. So many observers now occupy themselves with these observations that individual deductions, as regards rotation periods, had better be discontinued in favour of a collective effort to ensure safe and certain results. The plan of reduction initiated by Mr. Marth, and followed by Mr. A. S. Williams, Rev. T. E. R. Phillips, and others, is to be greatly commended, and there seems little doubt that in future years it will be generally adopted, and be the means of vastly increasing our knowledge of the surface vagaries of this wonderful planet.

In the drawings of Jupiter accompanying this paper no attempt has been made to show the slight curvature of the belts due to the inclination of the planet in 1898 and 1899.

[It should be noted that this paper was written in April, 1900.—EDS.]

THE HUNDRED BRIGHTEST STARS.

By J. E. GORE, F.R.A.S.

WE sometimes hear of "the Hundred Best Books," and there is much difference of opinion as to what these books are. But there can be little or no doubt as to the hundred brightest stars in the heavens, although the exact order of their arrangement—or sequence, as it is termed—may be somewhat uncertain. In the following table I have arranged the hundred brightest stars in the sky in the order of magnitude as measured with the meridian photometer at Harvard College Observatory (U.S.A.), and at Arequipa, Peru. For the stars visible in the Northern hemisphere the results are given in the "Harvard Photometry" (H.P.), and in the Revision of the same recently published, and for the Southern stars in the "Southern Meridian Photometry" (S.M.P.). When a southern star occurs in all three catalogues I have taken the magnitude given in the S.M.P., as the observations were evidently made under more favourable conditions. I have also given the magnitude of each star as measured with the wedge photometer at Oxford, and also in the Potsdam photometric catalogues (recently published) whenever the star is found in these catalogues. To make these catalogues strictly comparable it should be noted that the standard star Polaris is 2.15 magnitude in the H.P. and S.M.P. catalogues, 2.05 in the Oxford, and 2.34 in the Potsdam catalogue. The spectrum of the star's light is given from the "Draper Catalogue of Stellar Spectra," when the star is found in that catalogue, I. denoting the Sirian type, II. the solar type, and III. the third type Some are given from the Harvard Annals, Vol. XXVIII., Part I., and a few from other sources. I have also added the star's parallax and proper motion where these have been determined. I have placed the stars in order of brightness according to the H.P., as in that catalogue the comparison star was Polaris, a comparatively bright star, while in the Revision of the H.P. the comparison was λ Ursæ Minoris, a faint star (6.57).

The position of the stars are given for 1900.0, and the list may be useful to variable star observers as affording comparison stars for naked eye stars suspected of variation in light.

No.	Star.	R.A. 1900.0.		Dec. 1900.0.	Photometric Magnitudes.				Spectrum.	Parallax.	Proper Motion.
		H.	M.	° ′	H.P.	Revision of H.P.	Oxford.	Potsdam.		″	″
1	Sirius	6	40.7	S. 16 34	−1·43	−1·67	−0·95	—	I. (A ?)	0·39	1·32
2	Canopus	6	21.8	S. 52 39	−0·96	—	—	—	II.	0·03	
3	Arcturus	14	11.1	N. 19 44	0·03	0·07	0·31	0·27	II. (K)	0·018	2·28
4	Capella	5	9.3	N. 45 54	0·18	0·21	0·08	—	II. (F)	0·107	0·43
5	Vega	18	33.6	N. 38 41	0·19	0·10	0·14	0·41	I. (A)	0·034	0·36
6	α Centauri	14	39.8	S. 60 25	0·20	—	—	—	II. (G)	0·76	3·62
7	Rigel (β Orionis)	5	9.7	S. 8 19	0·32	0·28	−0·03	—	II. (F)		
8	Procyon	7	34.1	N. 5 30	0·46	0·47	0·50	0·75	II. (F)	0·27	1·26
9	α Eridani	1	34	S. 57 44	0·51	—	—	—	I. (B)		
10	β Centauri	13	56.7	S. 59 53	0·83	—	—	—	I. (B)	0·018	
11	α Orionis	5	49.8	N. 7 23	0·91	0·94	0·98	—	III.	0·009	
12	Altair (α Aquilæ)	19	45.9	N. 8 36	0·97	0·71	1·01	1·15	I. (A)	0·20	0·64
13	Aldebaran	4	30.2	N. 16 19	1·00	1·07	1·12	1·18	II. (K ?)	0·15	0·19
14	α Crucis	12	21.1	S. 62 32	1·02	—	—	—	I. (B)		
15	Antares	16	23.2	S. 26 13	1·06	1·14	1·13	—	III.		
16	Pollux (β Gemini)	7	39.2	N. 28 16	1·12	1·25	1·36	1·51	II. (K ?)	0·068	
17	Spica (α Virginis)	13	19.9	S. 10 38	1·23	1·09	0·96 / 0·81	—	"Orion type"	Negative	
18	α Pis. Aust.	22	52.1	S. 30 9	1·27	1·31	—	—	I.		
19	Regulus (α Leonis)	10	3.1	N. 12 28	1·42	1·34	1·17	1·76	I (A)	0·093	
20	α Cygni	20	38.0	N. 44 56	1·47	1·25	1·32	—	I. (A)	Negative	
21	ε Can. Maj.	6	54.7	S. 28 50	1·49	1·65	—	—	I. (A ?)		
22	β Crucis	12	41.8	S. 59 8	1·49	—	—	—	I. (B)		
23	γ Crucis	12	25.6	S. 56 33	1·55	—	—	—	III.		
24	Castor (α Gem.)	7	28.2	N. 32 7	1·56	1·61	1·53	1·97	I. (A)	0·198	
25	β Argûs	9	12.1	S. 69 18	1·73	—			I. (A)		
26	ε Argûs	8	20.4	S. 59 11	1·74	—	—	—	II. (K)		
27	ε Orionis	5	31.2	S. 1 16	1·76	1·71	—	—	I. (A)		
28	λ Scorpii	17	26.8	S. 37 2	1·79	1·79		—	I. (B)		
29	δ Can. Maj.	7	4.3	S. 26 14	1·85	2·16	—	—	II. (G ?)		
30	ε Ursæ Maj.	12	49.6	N. 56 30	1·85	1·76	1·80	—	I. (A)	0·030	
31	γ Orionis	5	19.7	N. 6 16	1·86	1·59	1·79	2·06	I. (B)		
32	ζ Orionis	5	35.8	S. 2 0	1·89	1·89	1·80	—	I. (A)		
33	α Trian. Aust.	16	38	S. 68 51	1·89	—	—	—	II. (K)		
34	β Tauri	5	20.0	N. 28 32	1·90	1·66	1·79	2·02	I. (A)		

No.	Star.	R.A. 1900.0		Dec. 1900.0.	Photometric Magnitudes. H.P.	Revision of H.P.	Oxford.	Potsdam.	Spectrum.	Parallax.	Proper Motion.
		H.	M.								
35	η Argûs	8	6.5	S. 47 2	1·91	2·37			Bright lines		
36	α Gruis	22	1·9	S. 47 27	1·92	2·10			I. (A)		
37	ε Sagittarii	18	17·5	S. 34 26	1·93	1·81			I. (A)		
38	α Persei	3	17·1	N. 49 30	1·94	1·85	1·93		II. (F)		
39	α Ursæ Maj.	10	57·6	N. 62 18	1·96	1·93	1·89	—	II. (K)	1·22 (?)	
40	θ Scorpii	17	30·4	S. 42 56	1·99	2·08			II. (F)		
41	γ Geminorum	6	31·9	N. 16 29	2·00	1·88	2·13	2·34	I. (A)		
42	δ Velorum	8	42·0	S. 54 20	2·00		—		I. (A)		
43	β Can. Maj.	6	18·3	S. 17 55	2·01	1·97	—	—	I. (B)		
44	α Hydræ	9	22·7	S. 8 14	2·02	2·29	2·22	—	II. (K)		
45	η Ursæ Maj.	13	43·6	N. 49 49	2·02	1·88	1·77		I. (A)	0·095	
46	α Arietis	2	1.5	N. 23 0	2·04	2·19	2·13	2·22	II. (K)		
47	α Pavonis	20	17·7	S. 57 3	2·05	—	-		I. (B)		
48	β Aurigæ	5	52·2	N. 44 56	2·07	1·98	1·94	—	I. (A)		
49	α Andromedæ	0	3.2	N. 28 33	2·08	2·09	2·05	2·44	I. (A)		
50	β Gruis	22	36·7	S. 47 21	2·09	2·14			III.		
51	λ Argûs	9	4·3	S. 43 2	2·10	2·37	—		K M		
52	β Ceti	0	38·5	S. 18 32	2·13	2·35	2·42	—	II. (K)		
53	β Ursæ Min.	14	51.0	N. 74 34	2·13	2·31	2·26	-	II. (L ?)	Negative	
54	γ Andromedæ	1	57·7	N. 41 51	2·14	2·26	2·14	—	II.		
55	α Ursæ Min. (Polaris)	1	22·0	N. 88 46	2·15	2·20	2·05	2·34	II. (F ?)	0·07	0·05
56	α Ophiuchi	17	30.3	N. 12 38	2·18	2·10	2·23	2·54	I. (A)	1·57 (?)	
57	θ Centauri	14	0.8	S. 35 53	2·19	2·34	- -	—	II. (K)		
58	β Andromedæ	1	4.1	N. 35 5	2·21	2·17	2·21	2·33	III.		
59	κ Orionis	5	43.0	S. 9 42	2·22	2·20	2·42	—	I. (A)		
60	β Leonis	11	44.0	N. 15 8	2·23	2·28	2·07	2·62	I. (A)		
61	ι Argûs	9	14·4	S. 58 51	2·24		—	-	II. (F)		
62	γ Leonis	10	14·4	N. 20 21	2·24	2·35	2·12	2·45	II. (K)		
63	α Cassiopeiæ	0	34·8	N. 56 0	2·25	2·17	2·41	-	II. (K)	0·036	
64	ε Scorpii	16	43.8	S. 34 7	2·29	2·44	—		II. (K)		
65	γ Cassiopeiæ	0	50·7	N. 60 10	2·30	2·23	2·19		"Orion type"	0·05 (?)	
66	σ Sagittarii	18	49.1	S. 26 25	2·30	2·02	—	—	"Orion type"		
67	γ Cygni	20	18·6	N. 39 56	2·31	2·33	2·26	2·50	II. (G)		
68	β Persei (Algol)	3	1.6	N. 40 34	2·31	—	2·40		I. (A)	0·07 (?)	
69	ζ Argûs	8	0.1	S. 39 43	2·33	2·36	- -		Bright lines		
70	γ Draconis	17	54.3	N. 51 30	2·35	2·48	2·10	—	II. (K)	Negative	
71	γ Centauri	12	36·0	S. 48 24	2·36	—	—	—	I. (A)		
72	δ Orionis	5	26.9	S. 0 22	2·36	2·59	2·02	—	"Orion type"		
73	α Coronæ	15	30·6	N. 27 3	2·37	2·25	2·23	2·10	I. (A)		
74	ζ Ursæ Maj.	13	19.9	N. 55 26	2·38	2·18	2·09	—	I. (A)	0·045	
75	ε Can. Maj.	7	20.2	S. 29 6	2·41	2·50	—	—	"Orion type"		
76	ε Pegasi	21	39·2	N. 9 25	2·41	2·67	2·43	2·76	II. (K)		
77	β Cassiopeiæ	0	3·8	N. 58 36	2·42	2·44	2·32	—	II. (F)	0·162	0·57
78	α Phœnicis	0	21.3	S. 42 51	2·45	2·40	—	—	?		
79	α Lupi	14	35·2	S. 46 58	2·46	3·33	—	—	I. (B)		
80	π Argûs	7	13·6	S. 36 55	2·49	2·92	—	—	?		
81	δ Scorpii	15	54·4	S. 22 20	2·52	2·49	—	—	"Orion type"		
82	η Centauri	14	29.2	S. 41 43	2·54	2·84	—	—	F line bright		
83	ε Bootis	14	40.6	N. 27 30	2·56	2·62	2·47	2·68	II.		
84	β Pegasi	22	58.9	N. 27 32	2·56	2·76	2·50	—	III. (M ?)		
85	γ Ursæ Maj.	11	48.6	N. 54 15	2·56	2·53	2·30		I. (A)	0·017	
86	ε Centauri	13	33.6	S. 52 58	2·58	—		—	I. (B)		
87	α Cephei	21	16.2	N. 62 10	2·58	2·63	2·57	—	I. (A)	0·061	
88	κ Scorpii	17	35·5	S. 38 59	2·59	2·60		—	I. (B)		
89	κ Velorum	9	19.0	S. 54 35	2·59		—	—	I. (B)		
90	β Ursæ Maj.	10	55.9	N. 56 55	2·60	2·57	2·17	—	I. (A)	0·011	
91	α Pegasi	22	59·8	N. 14 41	2·61	2·61	2·33	3·20	I. (A)		
92	η Ophiuchi	17	4.6	S. 15 36	2·62	2·60	2·42	—	I. (A)		
93	θ Aurigæ	5	52·9	N. 37 13	2·67	2·70	3·03	2·88	I. (A)		
94	α Leporis	5	28·3	S. 17 54	2·67	2·73	- -	—	I.		
95	α Ceti	2	57.1	N. 3 42	2·68	2·84	2·44	2·89	III.		
96	ε Cygni	20	42·1	N. 33 35	2·69	2·58	2·45	2·74	II. (K)		
97	δ Sagittarii	18	14.6	S. 29 53	2·69	2·98	—	—			
98	ζ Sagittarii	18	56.3	S. 30 1	2·69	2·79	—	—			
99	α Serpentis	15	39·3	N. 6 44	2·71	2·79	2·67	2·88	II. (K ?)		
100	β Aræ	17	17·0	S. 55 27	2·72	-		—	II. (K)		
(101	ι Aurigæ	4	50·4	N. 33 0	2·72	2·99	2·87	2·86	II. (K))		

Notes on the above List.

2. A very brilliant star which does rise above the horizon of London. Spectrum "early solar type" according to Huggins.

3. Sir William Herschel found Arcturus considerably brighter than Vega.

11. This star is variable to the extent of about half a magnitude.

13. This is generally considered as a standard star of the first magnitude. But it has been suspected of variation.

14. This is the brightest star in the Southern Cross.

15. The spectrum of this star is said to be "composite.
22. One of the stars in the Southern Cross
23. Spectrum according to Ellery.
35. This star was estimated 3.0 at Cordoba, and may possibly be variable. Sir John Herschel made it 2.44.
44. This star is red and a suspected variable
50. Spectrum according to Pechüle
53. This star has been suspected of variation.
54. Spectrum said to be "composite."
55. This is the standard star of the photometric catalogues, except the Revision of the H.P., in which the comparison star is λ Ursae Minoris, magnitude 6·57.
60. A suspected variable star. It was rated of the first magnitude by Al-Sufi in the 10th century.
63. This star is a variable, but has no regular period. The variation is from about 2.2 to 2.8, so that when at its minimum light, it is not among the hundred brightest stars.
66. The famous variable star. The variation is from 2.3 to 3.5, so that at minimum it retires for a few hours from the list of "hundred brightest stars."
72. A suspected variable star.
73. A suspected variable star.
76. A suspected variable star.
79. There is considerable difference of magnitude between the H.P. and the Revision of the H.P. The star was estimated 2.6. at Cordoba.
82. Spectrum with hydrogen F line bright according to Bailey.
83. The spectrum is said to be "composite."
84. A known variable star which varies from about 2.2 to 2.7, but with no regular period.
91. Allowing for difference of scale there is considerable discrepancy between the Oxford and Potsdam measures which suggests possible variation of light.

The lowest magnitude given in the list is 2.72. The following stars are brighter than this in the Revision of the Harvard Photometry:—

	h.	m	°	′			
α Columbae	5	36·0	S. 34	8	2·55	S.M.P.	2·74
δ Leonis	11	8·8	N. 21	4	2·68	H.P.	2·75
β Lupi	14	52·0	S. 42	44	2·68	S.M.P.	2·74
β Librae	15	11·6	S. 9	1	2·66	H.P.	2·74
β Scorpii	15	59·6	S. 19	31	2·70	H.P.	2·91
ζ Ophiuchi	16	31·7	S. 10	22	2·64	H.P.	2·84

Of the hundred stars in the list, 47 are north of the Equator and 53 south, so that the 100 brightest stars are pretty equally distributed in each hemisphere, with a slight preponderance in favour of the southern hemisphere.

I find that of the 100 stars in the list, no less than 58 lie in or near the Milky Way, a remarkable fact considering that the Galaxy does not—at most—cover more than one-fourth of the area of the star sphere.

With reference to spectra, there are 51 of the I. type (including those of the "Orion type"), 34 of II. type, and 7 of type III. Of the stars lying in or near the Milky Way, there are 32 of type I., and 19 of type II. This shows a marked preponderance of bright Sirian stars in the Galaxy.

It is, I think, a popular idea that the stars forming the Southern Cross are some of the very brightest in the heavens, but this is quite a mistake, as the brightest of them, α Crucis, is only 14th in the above list, the next, β Crucis, is No. 22, the next, γ Crucis, is No. 23, while the fourth star, δ Crucis, is not included in the first hundred brightest stars, its magnitude being only 3·08.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

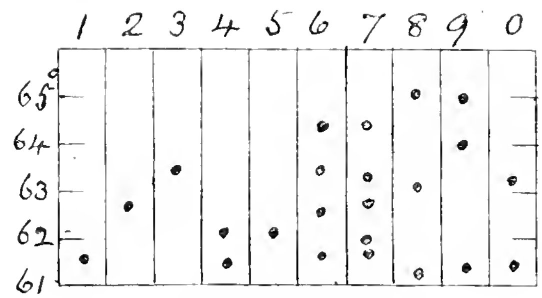
HOT AND DRY SUMMERS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Distinguishing each of the last 60 summers at Greenwich as either hot or cool, or as dry or wet (by relation to the averages), it may not be too obvious to remark that hot summers are not all dry, nor cool summers all wet. The following classification shows this:—

Hot and dry summers	23
Cool and wet...	19
Cool and dry...	12
Hot and wet...	6
	60

Let us arrange these 23 hot and dry summers in ten groups, according to their position in a decade; those of years ending in 1 together, those of years ending in 2 together, and so on; and represent each summer by a dot at level corresponding to the temperature. (The rainfall relation is not indicated in each case; it will be understood that all those summers had less rain than the average.)



Hot and Dry Summers.

In this rough diagram we might note the following among other points:—

1. The five hottest dry summers (64° and over) are all in the years ending 6 to 9.
2. Of ten summers over 63°, nine are in the decade half 6 to 0; and only one in the other half, 1 to 5.
3. The years ending 6, 7, and 8 have four times as many hot dry summers as those ending 1, 2, and 3 (12 to 3).
4. The summers of years ending in 7, are all hot and dry except one (1867).

These facts might perhaps be found useful in forecasting.

ALEX. B. MACDOWALL.

CRESCENT-SHAPED IMAGES OF THE SUN DURING THE ECLIPSE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—If you look under a tree when the sun is shining you will see that where the sun finds its way through the branches all the *small* spots of sunshine on the ground are of a circular or oval shape. This is due to the fact that the interstices between the leaves act like the lens in a camera obscura, or perhaps to be more accurate, they may be said to act like the pinhole in the front of a pinhole camera, and they therefore really project small images of the sun on the ground.

The curious thing is that whatever the shape of the interstices between the leaves, provided only that they are small, the spot of light on the ground is always of a round or oval shape. Our photographic readers will remember that the same thing is noticed with the stops of their lenses, whether the aperture of the stop is round, oval, or square, the image on the ground glass is the same. Of course to get the spots of light on the ground quite circular the surface of the ground must be at right angles to the ray of sunshine which finds its way through the leaves. In this country, however, the sun is never vertical, so the sun images are

Crescent-shaped Images of the Sun during the Eclipse.

generally of an oval shape, except only in the rare cases where the ground happens to slope in such a manner that the sun's rays strike it at right angles.

During an eclipse the images of the sun assume the crescent shape of the sun itself, and in the accompanying photograph, taken on May 28th last, a number of spots of a crescent shape will be seen on the fence and on the road. The large irregularly shaped patches of sunlight are cases in which the sun has been shining through spaces too large to act as a "pinhole-lens," or where images from several apertures have fallen over one another. E. Pierce.

"Claremont," Balfour Rd.,
South Norwood.

ASTROLOGY.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I should like to appeal against the antipathy which appears to exist against those doctrines usually termed astrological.

The majority of astronomers, without the least examination of the subject, reject the idea of planetary influence as being totally unworthy of their consideration, completely ignoring the fact that there are hundreds of proofs in its favour.

No modern scientist would think of denying that between the sun and the planets, and the planets and each other, there is a mysterious connection, akin to electricity, which manifests itself in gravitation, centripetal attraction, and perturbations of their orbits. Why, therefore, should not this mutual influence show itself, psychically, so to speak, in the destinies and characters of a planet's inhabitants?

Pythagoras, whom we have every reason to believe originated the modern system of astronomy, was undoubtedly a believer in astrology, and the famous Kepler was also an adherent to its teachings.

I wish that some of your readers would give the matter a sound and unbiased investigation which would prove whether the Egyptians, the Chaldeans, and other highly-civilised races were wrong in the opinions they entertained for many thousands of years.

240, Holloway Road, N. B. Chatley.

[In reply to Mr. Chatley it is sufficient to say that astronomers do not care to waste time on an examination into astrology, for the reason that there is nothing in it to examine. It is simply a gross imposture, a special form of Fetichism, *i.e.*, of the arbitrary ascription to inanimate objects of mysterious powers, entirely apart from any physical and material action. The only excuse it ever had was in the days of bygone heathendom, when the sun, moon, and planets were looked upon, not as things, but as beings: as Gods, in fact, and were worshipped as such.

But as compared with the English astrologer, the West African negro shows himself much the more reasonable and intelligent. The latter, if his fetich does not bring him the expected good luck, will kick or beat it, and consign it to the dust-heap. The former, if Venus and Mercury do not justify his anticipations, does not dream of reconsidering his notions as to their "influences," but goes on still blindly believing in spite of the clearest evidences against him.

Present day astrologers can neither tell when or how the special "influences" supposed to reside in each individual "planet" or "house" were determined, nor give the observations upon which primitive astrology was based? They choose to call Jupiter "fortunate" and Saturn "malign"; but if anyone should think fit to reverse the attributes, who could contradict him?

Mr. Chatley asks "whether the Egyptians, the Chaldeans, and other highly-civilised races were wrong in the opinions they entertained for many thousands of years." If modern astrologers are right, they certainly were. For the ancients recognised but seven planets, whereas there are—according to modern astrologers—nine. That is to say, in the opinion of the ancients Uranus and Neptune had no influence, for they never detected anything wrong in their calculations, as they should have done if these planets were really potent.

By-the-bye, if these two new planets have any astrological power upon the characters and fortunes of men, how is it that astrologers did not discover them centuries ago? The astronomers had to wait till sufficiently powerful telescopes had been constructed; the astrologers had their materials for study—nations, cities, and individual men, all ready to their hands.

Again, when Uranus and Neptune had been discovered, from what observations, and by what process of reasoning were their specific influences defined?

Further, can astrologers tell us now, by the "outstanding differences" between their predictions and their fulfilments, whether there are more planets to be discovered, beyond Neptune or within the orbit of Mercury?

One point more, the force of gravitation,—to which Mr. Chatley alludes,—varies directly as the mass of the attracting body, and inversely as the square of the distance. Is it so with the "astrological" or "psychical" force of the planets? Does any astrologer know? If it does not vary according to the same law, does it vary at all for any given planet, or is it always the same for the same body whatever its distance, and equal for all the planets whatever their mass? Or if there be any differences, what is the law governing them? No astrologer can tell: yet without such knowledge astrology stands a fraud self confessed.

[E. WALTER MAUNDER.]

MIRA CETI.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The usual diligence did not always permit as satisfactory observations of Mira at its last appearance but they were begun earlier and continued later, and altogether may be regarded as a fair exhibit of the star's movement.

O CETI MAXIMUM.

1899.	Mag.	1899.	Mag.
July 19.	7·10	Oct 21.	5·18
„ 31.	5·02	„ 22.	5·45
Aug 3.	5·02	„ 22.	5·31
„ 6.	4·92	„ 23, 24, 25.	5·47
„ 10.	4·37	„ 26.	5·12
„ 12	4·42	„ 28, 29.	5·33
„ 20	4·26	„ 31.	5·28
„ 21	4·57	Nov. 3.	5·38
„ 22.	4·41	„ 5.	5·41
„ 22.	4·45	„ 8.	5·67
„ 24.	4·47	„ 9.	5·73
„ 31.	4·37	„ 10.	6·20
Sept. 2.	4·08	„ 22.	6·13
„ 3.	4·85	„ 23	6·05
„ 6.	4·95	„ 28.	6·95
„ 7.	4·75	„ 29.	6·91
„ 11.	5·07	„ 30.	6·93
„ 13, 15.	5·02	Dec. 1.	7·00
„ 19.	4·85	„ 2.	7·00
„ 21.	4·00	„ 3, 4.	6·85
„ 23.	4·45	„ 5, 6	7·15
„ 24.	4·00	„ 11.	7·50
„ 25.	4·25	„ 21.	7·91
„ 26.	4·51	„ 25, 26.	7·95
„ 27.	4·61	„ 28.	7·97
„ 29.	4·86	„ 29.	8·10
„ 30.	4·92	1900.	
Oct. 1.	4·29	Jan. 1.	8·00
„ 2.	4·41	„ 2	7·97
„ 3.	4·92	„ 3	7·92
„ 4.	4·97	„ 4.	7·87
„ 5.	5·02	„ 14.	8·50
„ 7.	4·91	„ 20.	8·60
„ 8.	5·07	„ 21.	8·62
„ 12.	5·28	„ 22.	8·52
„ 13.	5·29	„ 23.	8·60
„ 15.	4·95	„ 25.	8·60
„ 16.	5·00	„ 31.	8·75
„ 18.	4·97	Lost for the Season.	
„ 20.	5·02		

The computed maximum was due September 3rd, but it cannot be definitely placed, though I incline to say 20th August. Minimum due 11th April was apparently not so far off at close of these observations. A difference of 2.5 magnitudes nearly between this maximum and the previous one will not escape remark.

Memphis, Tenn., U.S.A. DAVID FLANERY.
20th April, 1900.

THE HYPOTHETICAL PLANET.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I have read with much interest Mr. Denning's letter contained in KNOWLEDGE for June, and I agree with him in all particulars. It is practically certain that if there is a planet revolving within the orbit of Mercury it has never yet been detected as such. No one disputes the irregularities of the movements of Mercury, but that any observer with any pretensions to astronomy should claim to have *seen* an intra-Mercurial planet in the act of transit, is, in my humble opinion, either wanting in good faith, or lacking in the qualifications of good sight and experience.

Some observers are apt to forget that, besides having an apparent motion, sun-spots have also a proper motion, and with all due respect to the memory of so capable an observer as Webb, he seems to me to have easily fallen a prey to this rut, and unconsciously mistaken sun-spots with proper motions for bodies revolving inside the orbit of Mercury. "Vulcan" has yet to be seen, not by *one* observer, but by many, since it is hard to think that it would escape the vigilance of so many experienced astronomers dotted all over the globe, who daily make it their practice to look out for any strange phenomenon in or near the sun's immediate neighbourhood. G. MCKENZIE KNIGHT.

Vale View, Barrells Down,
Bishop's Stortford.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

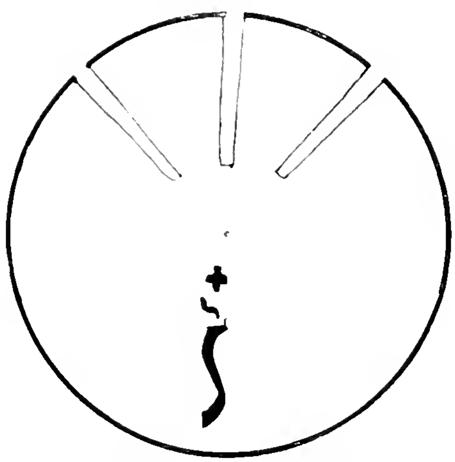
GOLDEN ORIOLES IN DEVON.—At least one pair (I say *at least* one pair, because the birds have been seen in places so far apart that I suspect there *may* be more than one pair) of "Golden Orioles" has been seen here at intervals for the last two or three years; but whether the birds breed in the neighbourhood or not I cannot say, but I have seen them in the months of June and July. I know the birds by sight, having seen a pair which used to build at Beaulieu Abbey, Lord H. Scott's place in Hampshire. I will ask you not to publish the name of the locality for fear the birds might be shot.—ARNOLD D. TAYLOR, Devon, August 3, 1900.

The Melodious Warbler (Hypolais polyglotta) in Sussex. (The Ibis, July, 1900, p. 569.) Mr. W. Ruskin Butterfield, in a letter to the *Ibis*, records that a bird of this species was obtained on May 11th, 1900, at Ninfield, Sussex. The bird has been examined by Mr. Hartert, as well as by Mr. Howard Saunders, who confirm Mr. Butterfield's identification. This is only the second time that the bird has been positively identified as occurring in this country, although it has no doubt often occurred and been overlooked. The first specimen was also obtained in Sussex (see KNOWLEDGE, November, 1897, p. 257).

The Natural History of the Ruff. By Charles J. Patten, B.A., M.D. (*Irish Naturalist*, August, 1900, pp. 187—209.) This is an exhaustive account of the occurrences and distribution of the Ruff in Ireland. Mr Patten also includes interesting details of the plumages and habits of the bird.

PRODUCTION OF COLOUR EFFECTS

A very singular experiment illustrating the production of colour effects by means of alternate after-images of black and white, has been devised by Mr. C. E. Benham, of Colchester. It is an extremely simple application of the principle of his already well-known artificial spectrum top, in combination with a wheel of life arrangement. To see the effect a circular piece of card has three slits cut in it. These slits radiate from the centre, and for the best effect should be within a quarter segment of the circle, and the width of the slits should not exceed the width of the pupil of the eye. Opposite the central slit a black line, dots, crosses, or in fact any other design in black, is traced. The whole of the back of the card is also blacked. The most perfect dead black for this purpose is made by mixing equal parts of methylated spirit and French polish with



some vegetable black. The disc is supported on a pin passed through the centre and revolved in *a strong light* in front of a mirror, the blackened side being towards the eye. On looking through the slits at the image in the mirror, the line, dots, or other design traced on the face will be seen threefold, and the three images will be seen to be coloured. The colours differ with different people, and with different rates of rotation, but in general the effect is red (the lowest), green, and dark blue, when the disc revolves from left to right; and dark blue (the lowest), green, and red, when the disc revolves from right to left. Colours are also seen with other dispositions of the slits, and also when there are only two, or when there are more than three, though it will be found that the arrangement described gives the most brilliant effects. The more slits, the slower must be the rate of revolution, and *vice versâ*. With only one slit there is of course only a single image, apparently stationary, and uncoloured. Two slits give two images, generally red and dark blue, and changing places as to their colour when the direction of rotation is reversed.

EROS AND THE ASTROGRAPHIC CONFERENCE.

For the fourth time the International Permanent Committee met at Paris on July 19, to discuss the future proceedings of the Astrographic Catalogue and Chart. Of the eighteen observatories which gave promise of support at the inception of the Astrographic Chart, three have not been able to fulfil their promises. These observatories, of the mutable South American Republics of Rio Janeiro, La Plata and Santiago (Chile), it is proposed to replace in the scheme by those of Perth (West Australia), Cordoba, and Monte Video. The moot questions of the publication of rectilinear co-ordinates with plate constants, or R.A. and declination of stars; of the measuring the diameters of stars by *scale* or by measuring screw; of giving a single exposure of 10 minutes or three exposures of 30 minutes each to the second series of chart plates; were still left to the several Directors of the eighteen observers to decide as it pleased them individually. Neither was it decided whether the chart plates should be reproduced by heliogravure, as is being done by the Paris Observatory, or by some less expensive method. For the moment it was resolved that copies should be made, but the method of so doing was not decided upon.

But a special committee was also appointed to take charge of the planet Eros during its approaching opposition. This committee consisted of the President, M. Lœwy, and of MM. André (Lyons), Bakhuyzen (Leyden), Christie (Greenwich), Elkin (Newhaven, U.S.A.), Gill (Cape of Good Hope), Hartwig (Bamberg), Prosper Henry (Paris), Trépied (Algiers), and Weiss (Vienna), and they submitted the following resolutions to the general Conference:—

(I.) It is desirable that the determination of the parallax of the planet Eros should be made by micrometric, by heliometric, and by photographic measures.

(*a*) By means of observations of the planet made when in the east and in the west of the same observatory;

(*b*) By the co-operation of the observatories of Europe and North America;

(*c*) By the co-operation of the observatories in the northern and southern hemispheres.

(II.) During the periods of observations of parallax, the daily motion of Eros should be determined as exactly as possible by micrometric, heliometric, and photographic measures.

(III.) The Committee recommend to observers of (*a*) and (*b*) that they should make measures on every morning and evening available, and to profit by the favourable atmospheric conditions to operate through as large hour angles as possible—this will diminish the error from the uncertainty of the planet's motion, and (*c*) that the mean times of observation should not greatly differ from the time of meridian passage of the planet at the southern station.

(IV.) It is necessary to take a special series of photographic plates of the regions surrounding Eros so as to determine the places of the comparison stars.

M. Hartwig will draw up a programme for heliometer observations of the planet; MM. André and Prosper Henry undertake to make researches on the atmospheric dispersion; and MM. Lœwy, Brown (Washington), and Bakhuyzen will undertake the task of executing resolutions concerning micrometric and photographic resolutions.

The observatories taking part are Algiers, Athens, Bamberg, Bordeaux, Cambridge (England), Cambridge (U.S.A.), Cape of Good Hope, Catania, Cordoba, Chicago (Yerkes), Edinburgh, Greenwich, Heidelberg, Leyden, Leipzig, Lyons, Marseilles, Minneapolis (U.S.A.), Mount Hamilton, Nice, Paris, Potsdam, Rome (Roman College), San Fernando, Strasbourg, Tacubaya, Toulouse, Upsala, Vienna (Ottakring), Vienne (Währing), and Washington.

Notices of Books.

THE SCIENTIFIC RESULTS OF DR. NANSEN'S EXPEDITION.

"THE NORWEGIAN NORTH POLAR EXPEDITION, 1893-1896. Scientific Results." Edited by Fridtjof Nansen. Vol. I. (Longmans.) A popular narrative of Dr. Nansen's famous expedition has been published, as is well known, in many editions and in many languages. Considering the great interest taken in the expedition and its results all over the world it is no small compliment which the explorer pays to the British nation in deciding to publish the scientific results only in the English language. The volume under review contains five memoirs, which are noticed below under their separate titles. We are promised four or five more volumes, which will appear from time to time, the whole work being completed in about two years' time. In order to place the various memoirs before the scientific world at the earliest possible date, they are printed as they are finished, without regard to systematic sequence. And as each memoir is paged separately and is given a number, we cannot see that the plan will lead to any confusion. In the preface to the present volume, Dr. Nansen pays a high tribute to his companions on board the "Fram," and we would add that Dr. Nansen and his companions are indeed deserving of the highest praise in bringing home such abundant and valuable scientific materials in the face of many obstacles. Not only had the ordinary difficulties of Arctic travel to be contended with, but owing to the necessarily small size of the "Fram" in proportion to the amount of provisions, coal, and equipment she had to carry, no room could be found for special laboratories, and, worse still, the "crew" had to be reduced to a minimum, and thus a number of observations of various kinds had to be undertaken by each man.

Both the letterpress and plates of the volume are well printed, but we do not admire the character of the type used. Only the most trifling errors of spelling in technical terms mar the perfection of the English.

"THE FRAM." By Colin Archer. pp. 16, with 3 Plates. It is fitting in every way that the scientific results of the expedition should commence with a description of the wonderful ship which bore the expedition with such success. And what more fitting than that the designer and builder of the "Fram" should describe how she was built, how she was rigged and equipped, and, above all, how she was made capable of resisting what no ship had ever before successfully resisted, the overwhelming pressure of the polar ice.

The leading idea of the whole expedition was to get the "Fram" frozen fast in the ice, which, according to Nansen's famous theory, drifted across the North Pole. To do this a boat had to be built which would overcome that pressure which was generally believed to be irresistible. That such a boat could be built and has been built all the world now knows. Although it is probably less well known that notwithstanding the enormous ice pressure to which the "Fram" was subjected—so graphically described in "Farthest North"—on being carefully surveyed both outside and in the hold after her return, the only sign of straining which could be discovered in any part of the vessel was in one bolt which had started! No better testimony to the efficiency of Colin Archer's design and system of construction could be adduced. The most interesting and important points about the "Fram" are the strength of the structure which resisted the pressure and blows of the ice, and the design which enabled her to evade a pressure which might have proved fatal even to her. Wood from many trees and many countries go to make up the strength of the "Fram." Her keel is of American elm, her double frames are of well seasoned English oak, the main deck beams are of American or German oak, while the inner lining, the keelston, the lower deck and poop beams, and all the deck planking are of Norwegian pine. The outside planking is double and all oak, the inner layer being 3 inches and the outer 4 inches thick, while over this again is an ice sheathing of greenheart, 6 inches thick at and above the water-line, decreasing to 3 inches thick at the keel. The interstices between the frames are filled with a composition of coal-tar, pitch, and sawdust, the ship's side thus forming one compact mass varying in thickness from 28 to 32 inches. In his choice of model the builder was largely influenced by the idea that the "Fram" should be lifted by the ice, and that thus the force of the "nip" should be broken and deprived of half its terrors. "In order to utilise this principle," Mr. Archer writes, "it was decided to depart entirely from the usual deep-bilged form of section, and to adopt a shape which would afford the ice no point of attack normal to the ship's side, but would, as the horizontal pressure increased, force the attacking floes to dive under the ship's bottom, lifting her." How successfully this end was realised we know from Dr. Nansen's account in "Farthest North." Mr. Colin Archer's description of the "Fram" is excellent, and with the two plans accompanying it will form a very valuable aid to future Arctic work.—H. F. W.

"THE JURASSIC FAUNA OF CAPE FLORA, FRANZ JOSEF LAND." By J. F. Pompeckj. With a geological sketch of Cape Flora and its neighbourhood, by Fridtjof Nansen. pp. 147, with 3 Plates. This section forms a continuation of the work done by Dr. Kœttlitz, of the Jackson-Harmsworth Expedition. It is to some extent controversial, since Dr. Kœttlitz submitted his fossils to Mr. E. T. Newton, F.R.S., while Dr. Nansen's collection has been examined by Dr. Pompeckj, with results which differ in certain details. The fact that the fossils represent the most northern Jurassic fauna known to us adds greatly to their interest; and the publication of this work in English gives it a special claim on our gratitude and attention. The Jurassic clays of Cape Flora underlie a great capping of plateau-basalt, which has protected them in their adverse climatic position. Dr. Nansen remarks that the constantly frozen condition of the clays has probably prevented them from being pressed out and made to flow under the weight of igneous rock above them. Considerable interest was aroused when these strata were described before the Geological Society of London by Kœttlitz, Newton, and Teall, in 1897 and 1898, owing to the possibility that certain shales containing Jurassic plants were contemporaneous with the outpouring of the basalts. Dr. Nansen is now able to strengthen the view that "the greater part of the basalt is also of Upper Jurassic or Lower Cretaceous age" (p. 26)); Professor Nathorst has, moreover, come to the same conclusion respecting the basalts which he has investigated in Kong Karl's Land. The occurrence of terrestrial and estuarine strata of Jurassic age in these regions fits in with what we already know of the northern Jurassic province, from the Inner Hebrides to Brora, Andö, and onwards.

The result of Dr. Pompeckj's examination of the fossils, and of his comparison with the descriptions published by Mr. Newton, are clearly given on pages 108—133. Cadoceras is the prevalent ammonite, and the author concludes that no marine Jurassic strata newer than the Callovian are present. The Callovian is well represented. On the other hand (p. 127), Lower Bajocian marine beds are indicated in the strata N.W. of Elmwood. The differences between this correlation and that made by Mr. Newton are not of a very momentous character; but they affect to some extent our views as to the broad physiographic features of the Jurassic period (pp. 140—147). The alliance of the beds is shown to be with the Russian Jurassic, and even with the central European type (p. 137), rather than with the Jurassic of East Greenland.—G.A.J.C.

"FOSSIL PLANTS FROM FRANZ JOSEF LAND." By A. G. Nathorst. pp. 26, and 2 Plates. Cape Flora, the southern extremity of the group of islands known as Franz Josef Land is about 20 degrees from the Pole. How far northwards this Arctic archipelago extends is one of the many unsolved problems of the region of mysteries which lies within the Arctic circle. Franz Josef Land was accidentally discovered by Weyprecht and Payer during the search for the North-east passage in 1872-4. It was twice visited by Leigh Smith between 1880 and 1882, and at Cape Flora the Jackson-Harmsworth expedition was established in 1896, and was joined by Nansen and Johansen then on their sledge journey southwards. During his short sojourn with the English expedition Nansen studied the geology of the neighbouring country, and was frequently accompanied in his excursions by Dr. Kœtlitz, doctor and geologist to the expedition. Hearing of a "nunatak" (a spur of rock projecting through the sheet of ice), upon which plant-remains were to be found, Nansen's interest was aroused, and he and Dr. Kœtlitz visited it. "The spur of rock consisted entirely of basalt, at some points showing a marked columnar structure, and projected in the middle of the glacier at a height which I estimated at 600 or 700 feet above the sea. . . . At two points on the surface of the basalt there was a layer consisting of innumerable fragments of sandstone. In almost every one of these impressions were to be found, for the most part of the needles and leaves of pine-trees, but also of small fern-leaves. We picked up as many of these treasures as we could carry. . . . Some days later Johansen also chanced unwittingly upon the same place and gathered fossils which he brought to me."* Of these fossils Professor Nathorst gave a preliminary account in "Farthest North," and has now presented us with detailed descriptions and figures in the memoir before us.

The well-executed plates bear testimony to the exceedingly imperfect nature of the materials with which Professor Nathorst had to work. In his preface the author states that "most of the remains of the plants are very fragmentary, and as, moreover, the leaves in themselves are small, and are not by any difference of colour distinguishable from the rock, the examination of the material has been very arduous, having almost without exception

* Fridtjof Nansen. "Farthest North." Vol. II., pp. 483-4.

been made under the magnifying lens." This being so, it was above all essential that its examination should be conducted with that skill and caution which it is plain that Dr. Nathorst has brought to bear upon his task.

Considering the condition in which the fossils were found it is not surprising that their study has yielded no botanical or geological results of a startling nature. Their chief interest lies in the fact that "they give us our first insight into the plant world in the regions north of the eightieth degree of latitude during the latter part of the Jurassic period." The author concludes that these plant beds most nearly resemble the "previously known Jurassic floras from Siberia and Spitzbergen," and either belong to the upper part of the Oxfordian group or represent even later deposits. Some doubt exists as to whether the plant beds are in situ or have been intruded into the basalt, on account of which it is impossible to determine with certainty the geological position of the basalt. If Nansen is correct in supposing them to be in situ, i.e., interbedded between the basalts, we must assign the basaltic formation to the late Jurassic or early Cretaceous periods.

With regard to the plants themselves, Dr. Nathorst's work may be left to speak for itself. The shortcomings of this account of the fossil flora of the most northerly region of the globe which has been examined by the geologist and palaeobotanist are confined, as far as we are able to see, to the unsatisfactory nature of the materials it treats of, and for this, neither author nor collector is responsible. We offer our congratulations to collector, editor, and author upon the production of a thoroughly efficient account of a collection representing a most interesting portion of the Jurassic flora.—H. H. W. P.

"An Account of the Birds." By Robert Collett and Fridtjof Nansen. pp. 54, with 2 Plates. The birds observed in the high latitudes traversed by the expedition were, as might be expected, few in number. Altogether 35 species are treated of in this account, which is divided into four sections, the first dealing with the Siberian Coast in the autumn of 1893, and the second treating of the first summer, being from Dr. Nansen's notes on board the "Fram"; the third section describes the birds observed during the famous sledge journey, while the fourth section gives the observations made on the "Fram" after Nansen and Johansen had left in March, 1895, until the return of the ship in August, 1896. Although the birds seen were comparatively few the observations are of much interest and value. The bird to which chief interest is attached is Rhodostethia rosea, Ross's wedge-tailed or roseate gull. This beautiful rose-breasted bird is a truly Arctic species, and was first discovered by Sir James C. Ross in 1823, on Melville Peninsula. Since then the bird has seldom been obtained while its eggs are quite unknown. The first Ross's gulls seen by the expedition were eight young birds in August, 1894, when the "Fram" was in about 81 degrees N. lat., and 127 E. long. These birds were all shot, and those preserved are the youngest birds of this species ever brought home. They were just able to fly, and are worthily represented in an excellent coloured plate and photographic reproduction appearing in the Memoir. The species was met with again and in considerable numbers by Nansen and Johansen in July and August, 1895, on the north-east side of Franz Josef Land, where it was obviously breeding—perhaps on Liv island—although the explorers were unable to discover the nesting place, indeed, as we know, they had not much time for bird's nesting. The bird record for farthest north is held by a Fulmar (Fulmarus glacialis), seen on September 14th, 1895, when the "Fram" was in 85 degrees 5 min. N. lat., but had it not been for the fact that Nansen and Johansen made their "rush" for the north too early in the spring for birds to have appeared it is probable that even this record would have been beaten. No less than ten species were observed in the autumn of 1895, while the ship was north of 84 degrees, one of these being a little land bird—the snow bunting. The exact details given in each section regarding dates, localities, and habits of the birds observed make the account doubly interesting and valuable.—H. F. W.

"Crustacea." By Professor G. O. Sars. pp. 137, with 36 Plates. For the last forty years Professor Sars has been publishing, almost annually, some important contribution to our knowledge of crustacea, and has often issued several such works in a single year. Whether his capacity was inherited from his eminent father, Michael Sars, or was the result of early environment, others may decide, but the indisputable fact is that in carcinological literature he became a classic at the outset of his career. To the accuracy of observation and ardour of pursuit with which he began, and which have never fallen off or flagged, he has since added two qualifications, one of which is fitted to endear him to naturalists of our land and the other to naturalists all the world over. After experimenting with Norwegian, Latin, and French, for vehicles of scientific exposition, he has finally made himself an accomplished writer of English, as his present and all his recent works bear witness. Furthermore, he has mastered a still more cosmopolitan language, by becoming an artist so facile and so faithful, that, even if he described his species in an unknown tongue, their structure would be adequately understood from his skilful and copious drawings. The work before us contains no less than thirty-six plates, full of instructive details in regard to Amphipoda, Copepoda, and Ostracoda.

The pelagic Copepoda obtained greatly preponderate in numbers over the other groups, and for this an explanation is given in the introduction. In preparing the "Fram" for its projected expedition, the assumption of geographers had been accepted "that the Polar basin, north of Siberia and Franz Josef Land, could only be quite a shallow sea, with depths scarcely exceeding some hundred fathoms," and the zoological equipment was arranged accordingly. But then a wonder came to light. Enormous depths were met with. No rope has been provided for dredging or trawling in such abysses. Even for sounding a makeshift line had to be constructed out of the wire ropes of the vessel. For a water bottle or an ordinary lead this long drawn thread of steel sufficed, but not for hauling a dredge. This was disappointing, because, not only were the superficial strata of the almost ice covered sea abounding in life at all times of the year, and to the highest latitudes reached, but the greater depths excited tantalizing expectations, for "in many cases the tow-net was lowered to depths exceeding 200 or 300 metres, and, as a rule, the draught was considerably richer in such instances than when it was working in smaller depths."

The sounding-line, however, produced at least one interesting faunistic result, in which we find aristocratic names mixed up with singular coincidences and remarkable facts of distribution. First it should be mentioned that the "Challenger" brought home a single specimen of a new amphipod, about half an inch long, from a depth of 420 fathoms, in the Pacific, off Tahiti. This was described under the name of Cyclocaris tahitensis, and it is a rather peculiar member of the family Lysianassidae. To obtain a second specimen of this unique rarity one can imagine a rich enthusiast giving instructions for a search in the southern ocean. That has not yet occurred, but something less to be expected has come to pass. Dredging off the Lofoten Islands in 1898, at a depth of 1095 metres, the Prince of Monaco obtained among other valuable captures six specimens of a Lysianassid which M. Chevreux has named Cyclocaris Guilelmi. The generic name was necessary from the fact that the species stood in the closest possible relationship to the type from Tahiti. The specific name was given by special request of the Prince in compliment to the Emperor of Germany, who was on board the "Princesse Alice" when the dredge containing the new species was hauled in. But Prince and Emperor were not the first to obtain this bright red polar form. Already in 1894, at about the 80th degree of north latitude, it had been taken by the Norwegian Expedition, and Sars in discussing it says, "I had intended to dedicate it to our celebrated explorer, Professor Nansen." But neither was Nansen the first to secure it, for Canon Norman has just published, under the name Cyclocaris faroensis, a species which cannot, I think, be distinguished from that which has an Imperial namesake, and Norman's description and figures are based on "two specimens taken by Sir John Murray in the 'Triton' expedition of 1882, Stat. 8, Faroe Channel, lat. 60 degrees 18' N., long. 60 degrees 15' W., in 640 fathoms, temperature 30 degrees Fahr." The name given by Chevreux has priority, since his specimens, though the latest found, were the earliest described. Of those taken by the "Fram," the first were found clinging to the sounding line, but others were subsequently taken in the tow net, and one at least was so obtained at a station "north of the 85th degree of latitude," therefore more than a hundred degrees of latitude distant from its twin species off Tahiti, to which all three authors notice its resemblance.

Apparently for Amphipoda the record of "farthest north" is at present held by Amphithopsis glacialis, Hansen, which, along with half a score of species of Copepoda, is reported as having been taken at "85 degrees 13' N. lat., 79 degrees E. long."

Among the interesting new Copepoda which Sars here describes there is one which he names Hemicalanus spinifrons, giving a cogent reason for cancelling the generic name but leaving it uncancelled. He is more concerned with a point of more importance. No one of the eleven species hitherto included in the genus has ever been found north of the Mediterranean, so that it seemed to be quite southern in distribution. "It was therefore," Sars observes, "not a little surprising to find a specimen undoubtedly belonging to this genus in a sample taken from about the centre of the Polar basin traversed by the 'Fram.'" This and various other facts relating to the range of species and genera will no doubt attract the keen attention of naturalists, and these fruits of Arctic research will greatly strengthen their hopes of a rich harvest from Antarctic exploration.

Among the honours which may in some degree have compensated Nansen for the hardships of his Polar experiences, this fine contribution to the scientific results by his distinguished brother-in-law is entitled to stand in the front rank.—T. R. R. S.

"WIRELESS TELEGRAPHY AND HERTZIAN WAVES." By S. R. Bottone. (Whittaker.) 3s. The fourth and last chapter of this volume occupies nearly half the book, of which it forms by far the most useful and interesting portion. The author is evidently well versed in the requirements of the numerous amateur electricians who have much enthusiasm but few tools and little knowledge of their use. To amateurs of this class we can recommend the volume for the sake of this chapter. The instructions both for making and using the apparatus are given with such minute attention to practical and essential details that it is evident that the author has himself experimented with apparatus constructed by him in the manner which he describes. The introductory chapter is the least satisfactory part of the book. The very brief statement of certain elementary electrical facts would be of very little if any assistance to a reader having no knowledge of the subject and superfluous for others. Parts of it, moreover, are misleading. Both on pages 1 and 12 it is stated that an electrically charged body consists in rapid molecular vibration, and on page 3 it is suggested that conductors are bodies which freely transmit electrical vibrations while insulators do not. Now one of the things we do know about electricity is that insulators are the best transmitters of electric waves, and that the better conductor a body is, the more imperfectly does it transmit these waves, indeed a theoretically perfect conductor would act as an absolute screen to the transmission of electric action, being impenetrable to electric vibrations. On page 10, again, the author, referring to the strained condition of the insulating medium near electrically charged bodies, treats the air as a rigid substance, and does not seem to be aware of the physical properties of gases.

We should advise the author in his next edition to suppress this chapter entirely, and devote the space to enlarging chapter II., which might be done with advantage. It would also be advisable in a new edition to draw a clearer distinction between Mr. Preece's system of wireless telegraphy by means of electro-magnetic induction, and the utilization of the Hertzian waves which forms the basis of the system which has been brought into practical shape mainly by the indefatigable industry and skill of Mr. Marconi, aided as he has been by Mr. Preece and the resources of the British Postal Telegraph Department.

"OBJECT LESSONS IN BOTANY." Book II. By E. Snelgrove, B.A. (Jarrold.) Illustrated. 3s. 6d. One hundred lessons from forest, field, wayside, and garden, are herein embodied and neatly illustrated with simple woodcuts. The author's ideal in planning his work is thus expressed—"Whether education or mere instruction be its aim, that book is most likely to succeed that leads its readers along the same paths as the discoverers of the science must themselves have followed. Students should not have facts thrust at them, but should be shown how to find them out; steps should be made, not simply taken; conclusions should be drawn, not merely stated; definitions should be led up to and not started from." The lessons are designed to suit the capacities of children from nine to eleven years of age, and we think Mr. Snelgrove has very closely approximated to the laudable standard he set out to attain.

"CHATTY OBJECT LESSONS IN NATURE KNOWLEDGE." By F. W. Hackwood. (Longmans.) Illustrated. 3s. 6d. Here are brought together, in convenient form, a good selection of outline lessons on the common objects of nature. Teachers who experience difficulty in preparing object lessons of this kind will find Mr. Hackwood very helpful in the way of suggestion. A number of drawings, white on black, are scattered throughout the volume to serve as auxiliaries to the teacher in sketching on the blackboard.

"THE STRUGGLE FOR EMPIRE." By Robt. W. Cole. (Elliot Stock.) Mr. Cole in these pages makes an ingenious attempt to describe a great war between England and the inhabitants of the star Sirius in the year 2236 A.D. Those who enjoy following in the wake of the visionary may here find pleasant reading for an hour or two. War ships of the future according to the author's notion will be closely allied to Jules Verne's "Clipper of the Clouds." Of course, in the war with Sirius England wins, but only after a great sacrifice of life and ships. It is interesting to observe that the war office of this future period is credited with the fault ascribed to that of the present day, namely, unpreparedness.

"AN ESSAY ON MENTAL CULTURE." By G. A Hight. (Dent.) 2s. 6d. net. Our author seeks to impress on the mind the supreme importance of intellectual culture in these latter days, and the necessity for self-reliance in the solution of the many perplexing questions evolved by advanced thinkers. The book is an essay—nothing more: it contains much sound matter with which all thoughtful readers will agree, but a considerable portion is distorted by a strong personality. Plain speaking, indeed, is the most characteristic feature of the essay; right or wrong the author may be, yet truth and error are delivered with the same unreserve.

"SIGNALLING THROUGH SPACE WITHOUT WIRES." (The work of Hertz and his successors.) ("Electrician" Publishing Co.) ii and 133 pages. This is the third edition of Professor Lodge's well known little volume, generally known by the second title quoted above, which formed the first title in the first two editions. This third edition contains some 27 pages of interesting additional matter, including notes on his own recent researches in syntonic telegraphy. In referring to Professor Slaby's work on Spark Telegraphy, and to his having succeeded in signalling from 3 to 13 miles across land, Dr Lodge inadvertently does an injustice to Marconi in not pointing out that, according to Professor Slaby himself, he had not got beyond 50 metres until after he had witnessed Marconi's earlier demonstrations.

"THE FLOWERING PLANT." 3rd Edition. By J. R. Ainsworth Davis, M.A. (Griffin.) Illustrated. 3s. 6d. Actual dissection of the plants studied is insisted on by the author of the book under notice, to facilitate which easily obtained objects are figured and described instead of rare and often inaccessible ones. A special chapter on ferns and mosses forms the chief feature in this edition, an innovation which will be appreciated by most teachers, seeing that these plants are abundant everywhere and so imperfectly understood outside the ranks of the specialists.

"THE THEORY AND PRACTICE OF INTERPOLATION." By Herbert L. Rice. (Nichols Press: Lynn, Mass.) Professor Rice endeavours to give a simple, practical, yet comprehensive discussion of all that is useful concerning differences, interpolation, tabular differentiation, and mechanical quadrature—a complete exposition of all the tables required by a practical computer. Many of the tables are here printed for the first time, and are true to the nearest unit of the last figure. We note with regret that references to the writings of Walmesley, Mouton, and Lalande have been purposely omitted "because of the general inaccessibility of their works." Although the author has used with discretion the works of such writers as Encke, Loomis, and Newcomb, he has drawn very largely on his own resources in preference to the usual forms of analysis, but the subordination of facts and figures has been so thorough and masterly in the Professor's hands that we feel convinced the fundamental principles involved stand out the clearer as a result. The computations were all made in duplicate by independent methods, so that the absolute of accuracy is thus as near as may be attained.

"FERRIC AND HELIOGRAPHIC PROCESSES." By George E. Brown, F.I.C. (Dawbarn & Ward.) Illustrated. 2s. net. Practical in character and limited in scope, this book is intended to supply amateur photographers, draughtsmen, engineers, architects, surveyors, and others, who find the reproduction of tracings and drawings a matter of every-day necessity, with just enough exact knowledge to duplicate pictures and drawings by the so-called "blue process." Many devices are employed for varying the background so as, for example, to get a brown or other colour in place of the Turnbull's blue—effects produced by the employment of tinted paper or other means. Thorough working details are presented so that anyone with the aid of this book may readily master all the phases of the art.

"LIFE AND CORRESPONDENCE OF DR. ARNOLD." By Dean Stanley. (Ward, Lock.) Illustrated. 2s. "Arnold of Rugby" is a name more or less familiar to all. When we mention the fact that this work went through twelve editions during the late Dean's lifetime, its merits will be sufficiently apparent. The chief point about the present edition is that the book is presented in a most attractive form at a price within the means of the largest number. By far the greater portion of the volume is occupied with the great teacher's correspondence suitably interspersed with biographical details by his devoted pupil. Two good portraits of the master are given, together with views of the places Dr. Arnold was associated with during his lifetime.

We have received the August issue of the "Theosophical Review" (1s.), the organ of the Theosophical Society, containing contributions from Dr. A. A. Wells, Mr. A. H. Ward, and other writers. Persons interested in the subjects treated of in the Review should communicate with the Hon. Otway Cuffe, at 28, Albemarle Street, London. The publications of the Theosophical Publishing Society may be obtained at 3, Langham Place, London.

We have received two catalogues of physical apparatus from Messrs. Griffin, which will recommend themselves to those science teachers who are engaged in organised courses, and also to students working up for the London University practical examinations. This firm has adopted the excellent idea of making up complete sets of apparatus to suit the experimental portions of most of the well known text books, and thus a great deal of time may be saved by teachers and others desirous of following any special course of its application. We note also that Messrs. Griffin have issued some special X-ray regenerative tubes for use with Wehnelt's electrolytic break.

BOOKS RECEIVED.

Principles of Chess. 3rd Edit. By James Mason. (Horace Cox.) 2s. 6d.

A Rosebud's Lost Colour. (Pamphlet.) By S. R. Crockett. (Newnes & Guardian.)

White Cattle: an Inquiry into their Origin and History. By R. Hedger Wallace. (Reprinted from the *Trans. of the N. H. Society of Glasgow.*)

Variable Star Notes. No. 6. (Rousdon Observatory.)

Instructions for the Use of the Calculus. By W. Gorn Old. (Dellond, London.)

Subject List of Works on Photography. (Patent Office Library Series No. 2.) 6d.

Feilden's Magazine, August, 1900. 1s. net.

Flora of Bournemouth. By Edward F. Linton, M.A. (Mate and Sons, Bournemouth.) 8s. 6d. net.

The Application of Electric-Motors to Machine-Driving. By Andrew Stewart, A.I.E.E. (Rentell, London.) 1s.

West Ham Public Libraries: Annual Report, 1899-1900.

Miniature Chessboard and Chessmen. (British Chess Co.) 2s. 6d.

Over the Alps on a Bicycle. By Mrs. Pennell. (Unwin.) 1s.

Bulletins de la Société D'Anthropologie de Paris.

A Handbook of Photography in Colours. By T. Bolas, Alexander A. K. Tallent, and Edgar Senior. (Marion.) 5s.

An Account of the Oldest Books in the World. By Isaac Meyer, LL.B. (Kegan Paul.) Illustrated. 30s. net.

Nuove Osservazioni di Marte. V. Cerulli. 1898-99.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

THE MANY-TWINKLING FEET.

Amphipoda are much more abundant and useful than amphitheatres, though their name is less familiar. An amphitheatre is well conceived for convergent eyes, and an amphipod for divergent legs. Imagine the central space of an amphitheatre to be the body of an animal and its radiating gangways the legs, and you may then understand something of Latreille's intention in coining the word Amphipoda, which signifies, as he explains it, feet extended in every direction. These feet are not stiff and stony and uniform in pattern like the gangways to which I have compared them, but mobile, many-jointed, endlessly diversified, and, moreover, capable of being uplifted or downward bent at all sorts of varying angles. Like the Isopoda of the last chapter, the Amphipoda are fourteen-footed. That is to say, besides several other more or less leg-like appendages, they have seven pairs of legs attached to the central trunk. Just think what nature can do in the way of variety with us poor quadrupedal or quadrumanous creatures, making the front legs so long in the giraffe, so short in the kangaroo, so solid in the elephant, so slender in the gazelle, so handy in ourselves, so invisible in the bashful snake, and then fancy, if you can, how the same nature may run riot when there are seven pairs of limbs to play with instead of only two. The opportunity is not neglected.

Seeing that the majority of the Amphipoda take their pastime or at any rate pass their time in the ocean, a common environment might seem unfavourable to variability. But the environment, though continuous, is multiform, from surface to abyss, from tropical heat to glacial temperature, from strong salinity to a slight brackishness, from semi-stagnation to wild waves and racing currents, from pelagic expanse to the space between tidemarks, from tracts of mud and smooth fine

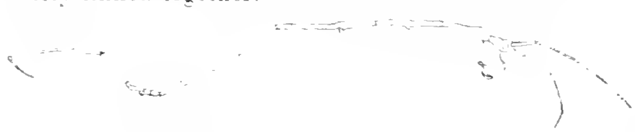
Scina rattrayi, Stebbing. Hyperid from Atlantic.

sand to coral reefs and ragged rocks, where the lost mermaiden dwelt of yore among the still surviving tangle of many-coloured algæ and zoophytes. Into all these situations, romantic or prosaic, and into some others, Amphipoda have found their way. Not so easy a thing is it to bury yourself in sand or sticky mud, and then to unbury yourself as if nothing had happened, with your coat as shining as before and every delicate hair uninjured. But many species of amphipods can accomplish this. To walk, to run, to climb, to delve, to build, to grasp the prey, to clasp the beloved one, to shelter the brood—these are obvious among the functions of the fourteen feet, as illustrated in the life-history of various species. How easily it all appears to come about, by shortening one joint, and lengthening another, widening this and narrowing that, with a little notching and sculpturing of margins, inflating or flattening of surfaces, curving the straight, straightening the crooked, feathering a hair, fortifying a setule into a spine, and behold for every function there arises its adapted form in permutations and combinations which arithmetic proclaims to be inexhaustible.

Pardalisca abyssi, Boeck. Gammarid, with eyes imperfectly developed.

This is a happy moment for beginning the study of the Amphipoda, because at present the order has definite and undisputed boundaries. Nothing that is not an amphipod wants to be one; nothing that is an amphipod wants to trek. First, there are the branchial sacs, simple or almost simple, not enclosed in a branchial chamber, and belonging to some of the trunk-limbs. Secondly, there is the pleon, which never has more than three pairs of swimming feet with lash-like branches. This combination of characters protects the Amphipoda from being confused with any other known crustaceans.

Also among themselves they form three groups to which nature has been pleased to give a rare distinctness. These are known as the Gammaridea, Caprellidea, and Hyperiidea, names derived from an early defined genus in each, to wit, *Gammarus* for the first, *Caprella* for the second, *Hyperia* for the third. The middle set resemble Manx cats and mankind and some other more or less interesting creatures in the circumstance that they have lost or nearly lost their tails, that part of the body which in the higher crustaceans is decorously designated the pleon. In the other two sets this part is rather powerfully developed, almost always carrying its proper complement of appendages, namely, three pairs of pleopods for swimming and three of uropods for jumping or some equivalent mode of progression. The pleopods show comparatively little variation, each usually consisting of a stout stem to which are attached two branches, many-jointed, and feathered with long setæ which are themselves feathered. The Gammarids and Hyperids are distinguished one from the other by a character in which the Gammarids agree with the Caprellids, a character not of the tail but of the head. The maxillipeds in the Hyperiidea have only three joints, the remaining four having for some mysterious reason vanished, whereas in the other Amphipoda some and usually all of these joints are present. Whether, therefore, by the head or the tail the three divisions of the order are clearly distinguished and at the same time closely linked together.



Parripalpus linea, Mayer. From Mayer.

The Caprellidea embrace two families, the Caprellidæ and Cyamidæ. The former of these are familiarly spoken of as spectre-shrimps and skeleton-shrimps, and in one of these species, the *Parripalpus linea*, Mayer, here figured, tenuity reaches perhaps its furthest amphipodan limit; nor does this precious specimen make up for want of breadth by any unnecessary length, since it is only two-fifths of an inch long. It may be proper to mention that in the lateral view, according to carcinological custom, the antennæ and legs of one side only are portrayed. The third and fourth peræopods are missing by accident. The first and second are missing in nature, nothing of them remaining but the little branchial sacs. Thus artistic convention, the frailty of the specimen, and nature's thrift, have combined to present the picture of a three-footed animal, which nevertheless has ten feet by rights, and by classification belongs to a fourteen-footed order. Cousins to the skinny clambering Caprellidæ, and closely resembling them in structure, are the more sedentary Cyamidæ, commonly known as whale-lice. In appearance these greatly differ from their near relations, because instead of being cylindrical and thread-like with geniculating bodies, they are comparatively broad and flat, adapted for close adhesion to the skin of their gigantic hosts. The Caprellidæ are ascetics subduing the flesh to such an extent that substance runs a risk of passing into shadow. The Cyamidæ, having adopted a lethargic life in oleaginous luxury, seem to be gradually recovering some of that corporeal amplitude which is appropriate to the epicurean.

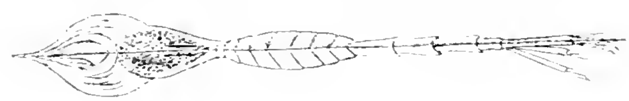
The Hyperids are not quite so accessible as the other two groups, being rarely found in England between tide-marks, except when thrown up by storms, either independently or on the jelly-fishes, which some of them frequent. Many of them are distinguished by the

Tetrathyrus moneauri, Stebbing.

extreme development of the eyes and by the glassy transparence of the body. Often in the female the second pair of the antennæ are obsolete. In the male the same pair frequently show a curious arrangement. They have delicately slender joints of great length, which, when not in use, can be folded together like a carpenter's rule and tucked away securely at the sides of the animal. In some genera the folding plan is carried further, being applied to the whole body, as in the *Tetrathyrus moneauri* and *Dithyrus faba* here figured. In *Tetrathyrus*, "four doors," and *Dithyrus*,

Dithyrus faba, Dana. From Dana.

"two doors," allusion is made to the greatly expanded joints of the two pairs of legs which precede the tiny last pair. It is a peculiar function for leg-joints to have to assist in armour-plating the owner's body. A comparison of the two figures will show how the animal by the infraventral folding of the broad joints in question, and the approximation of its head and tail, becomes a smooth little egg-like box, as compact a fortress of its kind as could well be devised. Very different in appearance but not so very different in structure is the *Calamorhynchus rigidus*, of which a dorsal view is given,



Calamorhynchus rigidus, Stebbing.

that does not show the rather insignificant legs. Its generic name, meaning "pen-beak," is appropriate to the form of the head in mature life, but it is born blunt-headed.

Of the three groups, the largest publicity and prominence has been obtained by the Gammaridea, and one can easily believe that from this type the other two are derived, because in each of those other two a feature has become degraded or lost which the Gammaridea still retain. The Gammaridea alone of the three have made their way into fresh water and on to dry land. It is, indeed, a fresh water species, *Gammarus pulex*, which the student has always at hand as a simple pattern with which to compare the innumerable modifications presented by the order at large. But *Gammarus marinus* on the shore and *Gammarus locusta* from the shore into tolerably deep water will provide him with equally suitable standards of comparison. To the eye of the beginner these three species will probably look as like as three peas, and will therefore serve him as a useful exercise in discrimination. The amphipods that have taken to life on land are not as yet very numerous. They all belong to the Talitridæ, a family better known as sandhoppers and beach-fleas. These show a great and good ambition to walk uprightly, but their education in the ways of sub-aerial life is evidently still in progress. Many are as yet in the stage of making experiments that are not always successful. Some, like the *Talorchestia* here depicted, steady

Talorchestia telluris, Bate. From Bate.

themselves by remarkable expansions of certain joints in the hinder limbs. Other devices are found in other families for species that whether in or out of water favour an ambulatory gait. In the open air an animal that falls over on its side and can then only move on by jerks and wriggles must painfully feel that, the more legs it has, the more ridiculous it looks.

Though species of amphipods swarm in all seas, they make themselves more than usually conspicuous in Arctic waters. Fittingly, therefore, the earliest intelligible description of any amphipod resulted from a voyage to Spitzbergen and Greenland. Friderich Martens, a barber-surgeon on board a whale-ship, toward the close of the seventeenth century, may be said to have discovered them. Some of the largest and most abundant of the smooth Arctic forms were described in 1774 by Captain Phipps, afterwards Lord Mulgrave, and some of the thorniest forms a little later by the Russian writer Lepekhin. *Eurythenes gryllus*, long the champion gammarid, was not made known till 1822. It has been found exceeding four and a half inches in length, with girth in proportion. It is in colour rosy with a tinge of yellow, and has its limbs æsthetically picked out with vermilion. Regardless of its array, petrels and sharks and other pirates swallow it without remorse. Their greediness first gave it to science, for Mandt, its discoverer, says, "the only specimen I brought back from my journey was vomited by an Arctic petrel." Sailors, after their wont, angling in the air for sea-birds, caught the petrel and gave it a mortal crack on its skull, whereupon it disgorged the crustacean, well digested, yet with the chitinous framework scarcely injured. This amphipod has a vast range from north to south. Also it descends through various depths to the greatest reached by any species of its order. Sea-birds must capture it near the surface, but whether they find it there alive or dead is uncertain. In any case one may still admire its powers of navigation, though it no longer holds the record for size. *Alicella gigantea* Chevreux, dredged by the Prince of Monaco in 1897 from a depth of 2890 fathoms, is five and a half inches long, thus beating the longitude of *Eurythenes gryllus* by an inch.

At the beginning of the chapter stress was laid on the variability of the seven pairs of trunk-limbs. There are twelve other pairs of appendages also more or less variable, but here at the end of the chapter it is impossible to expatiate on the changes they exhibit with their branches double or single, their joints many or few, their teeth and lobes, their hooks and spines, their feathers and functions. Even the eyes, which have no joints at all, and which are normally two, seated laterally on the head, are far from displaying monotonous similarity. For, instead of two, there may be four or three or one or none. They or it may be on the top of the head instead of at the sides, and on the projecting tip or further back. They may be compound or simple. The outline may be circular, oval, or collar-like, it may be reniform, lageniform, fusiform, that is, like a kidney, a flask, or a spindle, or it may be in divers ways irregular. The elements may be few or so numerous as to cover almost the whole cephalic surface. The colour may be bright red or brown or green or ferociously black, or again it may be white or grey or variously pallid to evanescence. There is just that one point of consistency about the eyes, that they are never stalked, never articulated. By a hemispherical bulging they may occasionally try to intimate that they could grow a stalk if they choose, but they never do choose.

In conclusion it may be said that persons of a fine sporting instinct, who desire to be exhilarated by the chance of experiencing savage nips and pinches, lacerations, stabs and bites, will find the Amphipoda of no use. Such persons must pursue the crab, the lobster, the prawn, the squilla, and the isopod. Among the Amphipoda there are a few species armed with strictly defensive spines, but otherwise they are of all the Malacostraca the most absolutely and universally peaceable towards mankind, never intentionally inflicting upon him any personal injury whatever.

SIR JOHN MURRAY AND THE BLACK SEA.

Sir John Murray recently delivered a lecture on the Physical, Chemical, and Biological Conditions of the Black Sea, to the Fellows of the Royal Society of Edinburgh. The Black Sea has peculiarities which distinguish it from the Mediterranean, Atlantic or Pacific. The greatest ascertained depth is 1200 fathoms. A surface current flows continually from the Black Sea into the Mediterranean through the Bosphorous and Dardanelles, and an undercurrent of salt water from the Mediterranean into the Black Sea. This undercurrent of water was found to be warm and to sink to the bottom, and in consequence of its great density prevented vertical circulation. The result was that these deeper waters were rendered quite stagnant. They were saturated with sulphuretted hydrogen and consequently life was impossible. In an expedition in which the lecturer took part, the water brought up by means of a water bottle from a depth of 300 fathoms smelt exactly like rotten eggs. No life therefore is possible in the Black Sea beyond a depth of 100 fathoms, which was a striking contrast to what happened in the open ocean, where there was an abundance of animal life at that depth. This brought about another extraordinary condition with reference to the deposits, viz., that in all the deeper deposits there is an abundant chemical precipitate of carbonate of lime, a condition of matters that obtains as far as is known in no other ocean.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

The following simple method for examining the gonococci of purulent ophthalmia is suggested by Dr. W. B. Canfield. A little of the pus is pressed between two cover glasses, which are then drawn apart. The glasses are allowed to dry, and are quickly passed through a Bunsen flame to coagulate the albumen and to fix the pus. A few drops of the ordinary methylene blue or violet are allowed to cover the specimen for a few minutes and washed off, after which the specimen may be examined in water or glycerine, or it may be dried and mounted in balsam, which makes it more distinct.

Permanent preparations of blood—amphibian for preference as the red cells are so large and contain such prominent nuclei—may be prepared by allowing fresh blood to fall drop by drop into a solution of osmic acid (two per cent. acid solution, one part; one per cent. solution of sodium chloride, two parts; distilled water one part). The solution should be constantly stirred while the blood is dropping. Allow the blood and acid to stand one night, and then wash the acid away with distilled water. Add alcohol, then clove oil, in which the blood may be kept indefinitely. Before the alcohol is added, the nucleus of the corpuscle may be stained in alum carmine; or the whole corpuscle may be stained in aniline blue. Mount in balsam.

A warm slide is an indispensable piece of apparatus to the student of histology. In the study of amœboid movements it is essential unless a suitable spot in the frog's web can be found. To make a warm stage, take a strip of copper the size of a glass slide, and make a diaphragm opening in the centre. Attach a long strip of copper to this—or the whole can be of one piece—sufficient to project about four inches over the edge of the stage of the microscope. The flame of an alcohol lamp heating the end of this strip will, by conduction, heat the whole piece together with the slide placed on it. A drop of blood being prepared for examination in the usual way, make a ring round the cover glass with oil to prevent evaporation, place on the warm stage, apply the heat, and the leucocytes can be studied in their movements with higher powers and with greater ease than in the frog's web.

A water bath is another very necessary adjunct where a certain very moderate degree of heat is not to be exceeded. Few persons fully appreciate the difficulty of regulating or even estimating the temperature of an object held over a naked flame, and mischief is often done before the operator is aware of it. A serviceable water bath is easily extemporized out of an old fruit can and a small beaker glass. This serves for exposing material and preparations to a temperature lower than that of boiling water. Where slides are to be so heated, the simplest contrivance is a flat tin box, with all the joints (cover and all) tightly soldered. A small tube closed with a cork serves to admit the water.

Sections of buds may be quickly prepared for class demonstration by the following method. Fix the specimen in the section cutter, wet it with alcohol, and slice off the sections, meanwhile keeping the knife flooded with alcohol. Place the specimens in alcohol tinged with iodine green, and leave them there for several hours until the solution becomes colourless. Next place them in a solution of alcohol and eosin, and leave them till they assume a pink colour. Pass them through an alcohol bath, immerse in clove oil for a few minutes, and mount in Canada balsam.

The curriculum of the elementary school has recently undergone a much needed and welcome reform. The new code contains, inter alia, the official sanction of the Board of Education for the recognition of nature study as a means of educating the children of the people. This is a step in the right direction, for when children are early taught the nature study of every-day life, and become familiar with the common things in nature around them, their ideas as to cause and effect in natural phenomena will cease to be associated with superstition and mystery, and the range of available information open to them will be indefinitely extended. No education that does not include a knowledge of the every day phenomena of nature can be regarded as complete; and as there is a very wide range of the most essential and practical knowledge that can be reached only through the microscope, the day may perhaps be not so far distant when the microscope, as an aid to nature study, will be used more extensively and more seriously in our public schools than it is at present. There is no reason whatever why a compound microscope of low magnifying power should not be just as much a common appurtenance of a well regulated elementary school as a blackboard or a piano.

All who are interested in microscopy and photo micrography should obtain a copy of an interesting little brochure entitled "Orthochromatic Photography," which is being distributed gratis by Messrs. Cadett and Neall, Ashstead, Surrey.

We have recently had an opportunity of experimenting with the "Absolutus" light filter used in conjunction with the Cadett Lightning Spectrum plates. The great rapidity of these plates, the sensitometer number of which was 360, renders them specially suitable for photographing the movements of microscopic plants and animals, while their extreme sensitiveness to all colour luminosities of the spectrum, excepting a very small margin at the extreme red end of the spectrum, enable them to represent with great delicacy the gradations in the coloured luminosities of stained preparations. The "Absolutus" light filter, which is specially adjusted for the spectrum plate, renders all gradations correctly with but a very small margin of error. It may be used either before or behind the objective. Its use increases the exposure at a window with a northern outlook about twenty times, but this is really no drawback with the Lightning plate, as, owing to its great rapidity, the exposure necessary is invariably shorter than it would be when using an ordinary plate without a filter. The surfaces of the "Absolutus" are optically worked, and the colouring accurately adjusted by the help of Abney's colour sensitometer to suit the spectrum plate. Workers with light filters know the unsatisfactory nature of ordinary coloured glasses and fluid cells. The care bestowed on the manufacture of the "Absolutus" eliminates most of the objections, and, in addition, the colouring of the screen is pleasant to the eye, and it does not interfere with the definition of the image.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* Knowledge.]

NOTES ON COMETS AND METEORS.

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

New Comet.—In justification of our statement in last month's notes that it was highly probable we should shortly hear of a discovery in this field, a bright comet with a tail was discovered by Borelly at Marseilles, and by Brooks at Geneva, U.S.A., on the night of July 23. The comet was moving rapidly northwards. The position at discovery was given by Borelly as 2h. 43m. 40s., Dec. + 12° 30′ in the extreme S.E. region of Aries. On the following night the comet was observed by Bigourdan at Paris, and the daily motion was found + 16′ in R.A. and +2° 18′ in Dec. On July 30 it was seen at Bristol in a 6¼ inch refractor; it was a conspicuous object with a bright tail, and in the beautifully clear sky which prevailed soon after midnight the comet was just perceptible to the naked eye.

Giacobini's Comet.—This object has now become exceedingly faint and is rapidly passing beyond the sphere of our observation. Its place on September 2 will be R.A. 17h. 39m. 7s., Dec. + 17° 58′·3, and its distance from the earth will be 169 millions of miles. The aspect of the comet will be such that only the largest telescopes will be able to deal effectively with it.

De Vico's Comet (1844 I.).—This object, which was computed to revolve in a period of about 5½ years, was not redetected during the half century which followed its discovery, but in August, 1894, Mr. E. Swift, son of the famous and veteran comet finder Lewis Swift, found a small periodical comet, the elements showing a striking resemblance of orbit to that of De Vico's comet, and it seemed probable that the two bodies were identical, allowing for some slight differences of orbit introduced by planetary perturbation. The return of the comet is now due, but the circumstances are not very favourable. In Ast. Nach. 3653 Seares gives a sweeping ephemeris, from which it appears that the object on September 2 will be in R.A. 16h. 17m. 19s., Dec. S. 25° 5′. This position is less than 1° N.E. of the star σ Scorpii, the place of which on January 1, 1901, is R.A. 16h. 15m. 10s., Dec. S. 25° 21′. The bright star Antares will be only 2 degrees E.S.E. of the comet at the same time. The latter will be about 190 millions of miles distant from the earth early in September, and far beyond the reach of ordinary telescopes.

Fireballs.—In the strong twilight at 8h. 47s. on July 17 a splendid fireball appeared over the north of England, and left a streak visible for more than three quarters of an hour. It moved somewhat slowly from south to north, and the nucleus burst out with great brilliancy several times, finally dividing into two fragments. Dr. C. O'Hara, of Burnley, describes the meteor as falling at an angle of about 45 degrees, and in a low altitude a little east of north. At Spennymoor, Durham, its direction of flight was noted from 50° over the S.E. horizon to 15° above N.N.E., and duration 2½ or 3 sec. The same observer says the fireball consisted of two pear shaped masses, tailing off behind into two parallel streaks of vivid white brilliancy accompanied by blue and crimson coruscations. The writer has received about 15 accounts of the meteor from various observers in the N. of England and Scotland. The real path of the object appears to have been from a height of 58 miles over Pickering, Yorks, to 15 miles over the North Sea. Its length of observed path was 175 miles, and its astronomical radiant point was at 249°—20° a few degrees N.E. of Antares in

Scorpio. The meteoric system to which this brilliant object belongs is a remarkable one, for it furnishes many large fireballs in the summer months.

On July 18, at 11h. 55m., a meteor as bright as Jupiter was seen by Prof. A. S. Herschel at Slough, by Mr. H. S. Campbell at Croydon, and others. It was a most extraordinary object, for it had a very slow-moving motion. It was very low in the air, for its computed heights were from 33 to 23 miles over Suffolk, and velocity only 7 miles per second.

On July 23, at 1h. 7m., a fine meteor, seen in its greatest splendour over the eastern counties of England, and considerably exceeding the lustre of Venus, fell from heights of 68 to 26 miles over the coasts of Essex and Norfolk. It had a path of about 155 miles, velocity 14 miles per second, and a radiant point at about 280° − 15°.

July Shooting Stars.—The fine, hot weather prevailing during the last half of July enabled a large number of meteors to be recorded by Prof. A. S. Herschel, Mr. W. E. Besley, the writer at Bristol, and other observers. The earliest indication of the Perseids was noticed on July 16, and the shower gradually developed in intensity on later nights. The easterly motion of the radiant was distinctly traced. A fine Perseid was seen by Prof. Herschel at Slough, and by the writer at Bristol on July 19 at 11h. 40m. Its radiant was at 17° + 50°, and it fell from 81 to 51 miles. Another bright Perseid was recorded on July 24, 12h. 12m., by Prof. Herschel, Mr. W. E. Besley, and the writer, shooting from a radiant at 24° + 52°, and descending from 84 to 55 miles. Many interesting minor showers were seen in July. The most active display of all seen by the writer was that of the Aquarids from a radiant at 338° − 10°, which furnished 23 meteors out of an aggregate of 177 observed between July 15–30. One of these was a very curious object. It appeared on July 21 at 11h. 5m., and looked like a small nebulous streak running slowly across the sky. Its path was 85 degrees long from 324° + 25° to 115° + 6.6°. The meteor seemed to be very feebly incandescent, and was directed from a radiant on the horizon at about 321° − 33°.

THE FACE OF THE SKY FOR SEPTEMBER.

By A. Fowler, F.R.A.S.

The Sun.—Sun-spots and faculæ may be looked for, but they are not likely to be either numerous or large. On the 1st the sun rises at 5.14 and sets at 6.46; on the 30th he rises at 6.0 and sets at 5.40. He enters Libra, and Autumn commences at noon on the 23rd.

The Moon.—The moon will enter first quarter on the 2nd at 7.56 A.M.; will be full on the 9th at 5.6 A.M.; will enter last quarter on the 15th at 8.57 P.M.; and be new on the 23rd at 7.57 P.M. The principal occultations are as follows, that of Saturn on the 3rd being especially notable:

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Sept. 3	Saturn	—	7.[illegible] P.M.	128	12[illegible]	8.11 P.M.	217	206	9 16
,, 4	[illegible]	5.[illegible]	7.[illegible]	62	66	8.[illegible] P.M.	271	26[illegible]	10 16
,, 15	13 Tauri	5.4	9.1 P.M.	76	99	10.4 P.M.	273	311	19 1[illegible]

The Planets.—Mercury is not well placed for observation this month. He will be in superior conjunction with the sun on the 13th.

Venus is a morning star, reaching greatest westerly elongation of 46° on the 17th. The time of rising is about 1.30 A.M. throughout the month. She passes from Gemini into Cancer about the 5th, and into Leo about the 26th, the path being towards Regulus. At the middle of the month the diameter of the planet is 24″.4, about half the disc being then illuminated.

Mars rises shortly before midnight during the greater part of the month. The path of the planet is easterly, passing from Gemini into Cancer about the 19th. On the 5th the planet will be near Delta Geminorum, less than a degree to the north of the star. On the 15th the apparent diameter of the planet is 5″.2, and the illuminated part 0.915; the distance of the planet from the earth will then be nearly 168 millions of miles.

Jupiter remains an evening star, in Scorpio, but as it sets about half-past nine at the beginning of the month, and shortly before eight o'clock at the end of the month, there will probably be few opportunities of observing him. On the 1st, at 8 P.M., the planet will be in conjunction with the moon, 0° 51′ to the north. The most notable satellite phenomena are a shadow ingress of the first satellite at 7.51 on the 4th, a transit ingress of the second satellite at 7.21 on the 12th, an eclipse reappearance of the second satellite at 7 18.38 on the 11th, and a transit egress of the first satellite at 7.13 on the 20th.

Saturn is also an evening star, in Sagittarius, but perhaps too low for useful observation. On the 1st the planet sets about 11 P.M., and on the 30th soon after 9 P.M. The planet is stationary on the 2nd, and in conjunction with the moon, 1° 5′ south, at 8 P.M. on the 3rd. On the 22nd the planet is in quadrature with the sun.

Uranus is in quadrature with the sun on the morning of the 1st, and may perhaps be observed during the early evening. The planet sets soon after 9.30 P.M. on the 1st, and shortly before 8 P.M. on the 30th. The position of the planet is near Omega Ophiuchi.

Neptune is an evening star, in quadrature on the 22nd, rising shortly after 11 P.M. on the 1st, and about 9.17 P.M. on the 30th. The planet describes a short easterly path in Taurus, almost midway between 132 Tauri and Eta Geminorum.

The Stars.—About 10 P.M. at the middle of the month, Auriga and Perseus will be in the north-east; Taurus low down a little north of east; Aries, Andromeda, and Cassiopeia towards the east; Pisces a little south of east; Cetus low down from east to south-east; Pegasus, south-east; Aquarius and Capricornus nearly south; Cygnus almost overhead; Aquila and Lyra nearly south-west; Hercules in the west; Corona and Boötis to the north of west; and Ursa Major nearly due north.

Minima of Algol will occur on the 17th at 12.8 A.M., and on the 19th at 8.57 P.M. Omicron Ceti (Mira) may be expected to be at or near a maximum.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of August Problems.

No. 1.

1. Kt to R4, and mates next move.

No. 2.

(A. F. Mackenzie.)

1. B to R5, and mates next move.

B to QB7 also appears to solve this problem.

This problem was selected in haste and, following the example of the *British Chess Magazine*, whence it was taken, erroneously given as a three-mover. Solutions in three moves are of course adjudged correct.

Correct Solutions of both problems received from Alpha, K. W., H. S. Brandreth, H. Le Jeune, J. Baddeley, G. W. Middleton, W. de P. Cronsaz.

Of No. 1 only from G. A. Forde (Capt.), J. T. W. Claridge, J. Humble.

G. A. Forde (Capt.).—1. B to K7 will not solve No. 2 in two moves if Black replies by moving the Kt to Q3. The Bishop blocks the way of the Queen to Q6, and the Rook is undefended.

Max Judge.—The King cannot move into check in the position which you enclose, or under any circumstances. It is true that the Pawn is pinned, but the Black King would be taken *first* if, as you suggest, both players are breaking the intended rules. If Black is allowed to move into check, White would be allowed to capture the King even if he thereby exposes his own King to the risk of *subsequent* capture.

A. C. Waters.—See remarks on the problem above. Seventeen seems a reasonable number of solutions in three moves for a problem intended to be solved in two.

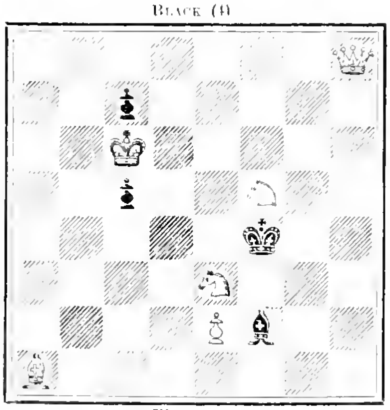
W. I. M. No doubt chess affords an excellent logical training for the mind, but I should scarcely go so far as to recommend it in preference to the study of Mill's Logic.

PROBLEMS.

No. 1.

By N. M. Gibbins (Brighton).

Black (4)



White (6)

White mates in two moves.

No. 2.

By C. D. Locock.

Black (8)

White (11

White mates in two moves.

CHESS INTELLIGENCE.

The International Tournament at Munich was brought to a conclusion with the following result:—

H. N. Pillsbury	12	Tie for first, second, and third prizes.
C. Schlechter	12	
G. Maroczy	12	
A. Burn ...	10½	Fourth prize.
G. Marco	10	Fifth prize.
W. Cohn	8	Sixth prize.
D. Janowski ..	7½	Tie for seventh and eighth prizes.
J. W. Showalter .	7½	
J. Berger ..	7½	
Wolf	7½	
Gottschall ..	6½	
Popiel	6½	
C. Halprin	6	
M. Billecard	3	
C. Von Bardeleben ..	2	
Jacob ...	1½	

The tie for the first three prizes has to be played off, each player contesting two games against each of the others. Pillsbury won the first game against Maroczy.

An examination of the score sheet shows that most of the prize-winners have come out in their correct places, judging by their form in the recent Paris tournament. Janowski has again come out lower than in previous years, while V. Bardeleben is evidently no longer the fine player he was when he held his own in tournaments against the very best masters some years ago. His health has no doubt broken down, and he has frequently retired before the conclusion of recent tournaments.

The Northern Counties Chess Union have challenged the Southern Counties to a correspondence match between teams of fifty aside, each pair to play two games simultaneously. The challenge has been accepted, and the match will begin early in October. Strong players desirous of having their names placed before the Selection Committee should write at once to Mr. T. M. Brown, 6, Wellington Place, Eccleshill, Bradford (North), or Dr. J. W. Hunt, 93, Richmond Road, Dalston, N.E. (South). The qualification is birth in one of the northern or southern counties, or a *bonâ fide* residence for the past twelve months.

The Chess Editor would be glad to receive some original problems in two or three moves for publication in this column. The talented composers who have contributed in this way for some years past have in many cases failed to send their customary problems this year. It is sincerely hoped that the omission will shortly be supplied.

The death is announced of William Steinitz, for many years champion chess player of the world. We hope to give a notice of his career next month.

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THE SMALLEST OF THE WILD CATTLE.

By R. Lydekker.

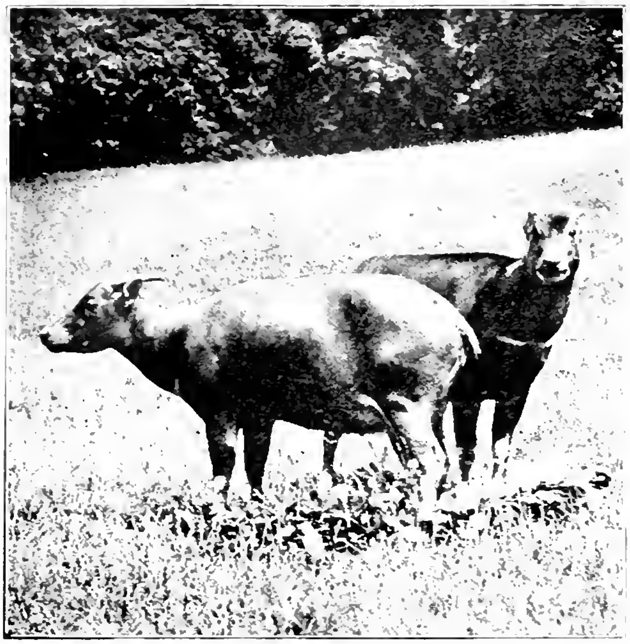
Among the larger mammals the species or varieties inhabiting islands are more or less markedly inferior in point of size to their nearest continental relatives. In the case of the smaller islands, like Sardinia and Corsica, the reason of such a diminution in stature is not far to seek, and it is therefore not in the least surprising to find that the Corsican red deer is a very inferior edition of its prototype of the mainland. The buffalo of the small island of Mindoro, in the Philippines, is greatly inferior in size to the wild buffaloes of the tall grass-jungles of Assam. In the case of islands of the dimensions of Sumatra and Borneo the reason of the phenomenon is by no means apparent, especially when we find them inhabited by a man-like ape (the orang-utan) almost rivalling in bulk and stature the gorilla of Western Africa. Nevertheless, even in such areas the same feature is to a certain extent noticeable, the wild buffalo of Borneo being considerably smaller than its Indian relative. As regards its actual area, the island of Celebes occupies a kind of intermediate position, since it is much inferior in extent to either Sumatra or Borneo, although far too extensive to come under the denomination of a small island. From its peculiar shape, which recalls the form often assumed by an amœba, it has, however, a much smaller area than could be enclosed by a ring fence than many islands of less than half its acreage, and this may really bring it, so far as the development of animal life is concerned, into the same category as a small island.

Be this as it may, Celebes has the distinction of being the home of the smallest living representative of the wild cattle, or, indeed, of the wild cattle of any period of the earth's history, for no equally diminutive fossil member of the group appears to be known to science. An idea of the extremely diminutive proportions of the anoa, or sapi-utan, as the animal in question is respectively called by the inhabitants of Celebes and the Malays, may be gained when it is stated that its height at the shoulder is only about 3 feet 3 inches, whereas that of the great Indian wild ox, or gaur, is at least 6 feet 4 inches, and may, according to some writers, reach as much as 7 feet. In fact the anoa is really not much, if at all, larger than a well-grown South Down sheep, and scarcely exceeds in this respect the little domesticated Bramini cattle shown a few years ago at the Indian Exhibition held at Earl's Court.

The anoa has many of the characters of the large Indian buffalo, but its horns are relatively shorter, less curved, and more upright. In this, as well as in certain other respects, it is more like the young than the adult of the last-named species; and as young animals frequently show ancestral features which are gradually lost as maturity is approached, it would be a natural supposition that the anoa is a primitive type of buffalo. This idea receives a remarkable confirmation from the circumstance that in the latter Tertiary strata of Northern India there occurs skulls of anoa-like buffaloes, which, however, in correlation with the continental area where they are met with, indicate animals of considerably larger dimensions than the living Celebes animal. In fact the latter, together with the somewhat larger wild buffalo, or tamarau, of the island of Mindoro, and the aforesaid extinct Indian species, constitute an altogether peculiar and primitive group of the buffalo tribe.

In its young state and during middle life the anoa is covered with a fairly thick coat of somewhat woolly hair, which is at first yellowish brown, but eventually becomes dark brown or blackish. In common with other Asiatic buffaloes, the hair is reversed along the middle line of the neck and back as far as the haunches; that is to say the tips are directed towards the head instead of towards the tail. What may be the precise object of this reversal (which is also met with among many antelopes and deer) is not yet ascertained. Possibly it may have something to do with the manner in which the animals rub themselves against the stems or boughs of trees and bushes.

In old individuals, especially those of the male sex, the coat of hair almost completely disappears, leaving the black skin bare and shining, like that of old buffaloes in general. This condition has been attained by the bull shown in the foreground of the accompanying photograph. And here it should be remarked that this particular animal has suffered the loss of the greater portion of its tail, which somewhat alters the appearance of its hindquarters. And, with the usual fatality that attends the grouping of animals, it has happened that the hind-quarters of the bull are in full view, while those of the cow are concealed." The somewhat spiteful and uncertain temper of the bull is indicated by the circumstance that it was found necessary to affix brass knobs to its horns. From the more typical buffaloes the anoa



Male and Female Anoa at Woburn Abbey.
From a Photograph by the DUCHESS OF BEDFORD.

differs by the general presence of white markings. These usually take the form of a gorget on the lower part of the throat, and of one or two spots on each side of the under jaw, as well as patches above the lateral hoofs; but there may also be white blotches on the neck and back, and in front of the eyes, while more or less of white may appear on the muzzle and the whole of the lower portion of the limbs. The special interest attaching to these white markings is that the spots on the sides of the face as well as the gorget on the throat are also met with among certain antelopes, such as the kudu and the bushbucks; and from this it has been inferred that the anoa is more nearly related to the antelopes than is any other member of the ox tribe. Although this may be true to a certain extent, the connection with the kudu tribe is remote.

According to the meagre accounts we at present possess of the creature in its native haunts, the anoa dwells in pairs on the elevated ground of the interior of Celebes, where it passes most of its time in thick forests in the neighbourhood of water. In associating in pairs it is quite unlike all other wild cattle, with the possible exception of the Philippine tamarau; and here again it presents a resemblance to the kudu and bushbucks, which also generally go about in pairs or small family parties.

Examples of the anoa are but rarely seen alive in England, although they do not appear very difficult to procure. The first specimen exhibited in the London Zoological Gardens was purchased in May, 1871, and a second was obtained by exchange in June, 1880. Between the latter date and 1896 (when the last complete list of the animals in the menagerie was published) not a single example of this very interesting little buffalo was obtained. At Woburn Abbey the pair represented in the accompanying photograph dwelt in a good-sized paddock by themselves and flourished for a considerable period. Unfortunately, however, one of the two has died since the photograph was taken.

Apart from the interest attaching to it as a primitive island type, and as being the smallest representative of the ox tribe, it cannot fairly be said that the anoa is a very attractive animal. It has nothing specially to commend it from an æsthetic point of view, being, in fact, a rather ugly and ungainly creature; and from its pugnacious disposition it is not adapted for turning out in British parks among other horned animals. Moreover, it has a decidedly delicate constitution, which alone would be sufficient to render it unfit for this kind of life.

THE BORDERS OF THE KARST.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

IF we ascend the Predil Pass from the Karinthian side, we rise above the fields of Villach to the typical landscapes of the Eastern Alps. At Raibl we are surrounded by the *débris* of the crags, and the white pebbles fill the valley-floor; still climbing, through the last firwoods, we look down into the rich green Raibler See, and then up to the notch that forms the passage through the limestone crests. After that all is limestone, down to the very shores of the Adriatic, and there we approach, with a feeling of satiety, the bare white plateaux of the Karst.

The learned Mojsisovics* reminds us that the Karst is occasionally clothed with grass upon its summits, and with woodland on its flanks towards the sea. Anyone who has gazed upon the Karst will feel, however, that he must insist on its essential barrenness.

The Aran Isles off the coast of Clare, and some surfaces in the west of Yorkshire, may give us an introduction to the nakedness of the Karst. In a limestone country, where storms prevail, on the one hand, or where dry seasons parch it, on the other, such soil as may be formed has little chance of preservation. The exposed surface becomes worn down along the planes of bedding of the strata; if these are gently tilted, the bare dip-slope may extend for miles; if they are horizontal, a dreary and unbroken plateau may result. Solution sets in along the prevalent joint-planes, and great open grooves arise, like the crevasses in the surface of a glacier. The water missing from the surface is found again underground, where it dissolves away the rock, and forms chains of caves and passages as it flows.

As we swing down the great curves of the Predil, under the peaks of the Mangart and the Terglou, the pebbly floor assumes more and more a feature of the landscape. The vegetation on the shifting limestone surfaces becomes broken up into little clumps, and acquires the monotonous dull green tint that seems characteristic of the east. The road in summer lies inches deep in hot white dust, as the Slovenian peasant knows too well, trudging down the ravine behind his thirsty flocks. At length we emerge on the plain of Görz, where Eocene sandstones and marls lend some diversity.† But there is a grim touch of the genuine Karst in the ridge that has still to be encountered, before the Italian deltas come in view.

The landscape reminds one mostly of pictures of

* "Zur Geologie der Karsterscheinungen." *Zeitschrift d. deutsch. u. oesterr. Alpenvereins,* 1880.

† See L. K. Moser, *Der Karst und seine Höhlen* (Trieste, 1899), p. 11.

the Holy Land. Stone walls bound the fields, scarcely distinguishable from the bare edges of the strata as they come out, one above another, on the hill. Dull lumpy trees, and forlorn patches of scrub, make dark spots upon the slopes, and gather together a little more closely in the shelter of some waterless ravine. The forlorn hamlet of Doberdo, by its name, should still be a Slavonic village; but from it we look down to the Adriatic, where the Italian population clusters along the shore. The delta below is covered with trees, and still banks us out from open water. As we drop from this bare dry summit to Monfalcone, we see the hills rising, one beyond another on our left, all of the same character, terraced with limestone edges, and spotted grudgingly with trees. The limestone here is Cretaceous, but the Eocene sandstones lie along the sea-front from below Nabresina to Trieste.

The plateau above Trieste, to an eye fresh from the riches of Karinthia, is a scene fraught with desolation About Nabresina, it is fair to say that continuous quarrying has made the country still more stony. The Romans built Aquileia from the Eocene and Upper Cretaceous limestone of these plateaux,‡ and lowered the blocks down an incline to the quays below. The great railway-embankment made in 1853 was constructed entirely from the rubbish rejected by the Romans. It is strange that Aquileia, since the assault of Attila, has completely disappeared; its walls and towers, villas and temples, have merely served to extend the desolate Karst from which it rose.

Various limestones go to form the plateaux that stretch southward, from the foraminiferal strata of the Eocene down to the Triassic dolomites. The main mass was upheaved by the first important Alpine movements, and the beds following the Eocene were laid down in freshwater basins.§

The Dinaric Alps are a somewhat early offshoot of the great Alpine system, and the surface now formed by denudation often follows the dip-slope of broad and gentle folds. The feature insisted on by Mojsisovics‖ is the occurrence of infilled lake-basins on this limestone surface, many of which date from Miocene times. These may easily be picked out on any detailed map, such as the Austrian staff-map on the scale of 1 : 200,000. The name "polje," or field, is given to them by the peasants, and is applied also to the alluvial stretches along the great rivers of Croatia. The Glamočko Poljo north of Livno is a fine example, in a closed basin 300 metres deep, thirty kilometres long, and fairly in the strike of the Triassic and Jurassic limestones. Modern alluvium partly covers the freshwater Tertiary deposits; but no water escapes from the hollows along the surface, and the streamlets that occur disappear here and there into the ground. The northern end is still occupied by a marsh. Mojsisovics ascribes the formation of these basins to the closing of valleys of erosion by barriers raised across the courses of the streams. "Almost every larger valley-system in Bosnia," he remarks, "possesses one or more Tertiary lake-basins. The old lakes are hence a common and characteristic feature of the Bosnian valley-systems, and their origin must be due to some cause operating on a wide scale, and affecting the whole region equally. The disturbances exhibited by the Newer Tertiary formations within the basins indicate that the upheaving forces in these districts were still in full activity, even in the most recent period."

Similar infilled basins, usually traversed by the rivers along which they have arisen, occur throughout the wooded region of the Bosnian highlands, on the east side of the typical and barren Karst. The plateau-country extends from Trieste through Dalmatia, West Bosnia, the Hercegovina, and Montenegro, and much is now being done by the Austrians to store up its water and to encourage the growth of trees.¶ The numerous small funnel-shaped depressions, called simply "dolinas," or valleys, by the Slavs, show how the atmospheric waters soak into the surface and enlarge their vertical channels by solution. But for a few artificial wells and cisterns, hundreds of square miles of the Karst-land would be practically impassable.

Asbóth,** whose admirable and unassuming book stands out amid all that has been written upon Bosnia, gives us some characteristic pictures of the south. Here is one from the neighbourhood of Mostar:—"Our eyes rest on nothing but cliffs and boulders, and between the stones venomous snakes and scorpions, long lizards, the carcases of dead animals, and the stumps and roots of fallen trees. The sky is of a transparent pale azure, the rocks ashy-grey, here and there changing into sand colour or rusty brown, the sparse vegetation being of a melancholy greyish-green. The whole, a Southern solitude, almost a desert, inhospitable and bare; and yet withal beautiful."

And this picture from Gacko, on the Montenegrin frontier:—"One feels that those who cling to this soil are born for battle. . . . Ashy-grey or glaring ochre-coloured stones of all sizes, from entire mountain masses, enormous blocks, and lofty pointed pyramids, down to small boulders, which everywhere cover the ground, and especially where there are passes leading across the Saddle. . . . Vegetation is almost entirely lacking, as is also water. Very seldom does a spring show itself, and then rapidly vanishes again amidst the chinks in the rocks, after having created a small oasis of green."

On the east flank of the Dinaric Alps, the Cainozoic earth-movements have brought up Palæozoic rocks along the folds, and a far greater diversity of scenery is the result. But a true Karst-land, formed of Cretaceous and Jurassic limestones, extends between Banjaluka and Jajce. The old road left the Vrbas valley just above the suburbs of Banjaluka, and struck up to the plateau, coming into more pleasant country as it dropped on to the long band of Lower Triassic sandstone at Varcar Vakuf. The new road, however, has been now carried up the gorge, which was previously inaccessible, even to pedestrians; its walls provide superb sections in the materials that form the Karst. Though the plateaux throughout Bosnia often coincide with the crests of broad and simple anticlinals, or with the level central portions of denuded synclinals, much subsidiary folding may occur within the limestone mass. Great thicknesses of the pale Jurassic and Cretaceous limestones have been brecciated, apparently by the Miocene earth-pressures, and the constituent blocks, ovoid and squeezed together, form a characteristic feature of the sections. Near Jajce itself, at the close of a series of magnificent

‡ Moser, *op. cit.*, p. 10.

§ A. Bittner, in *Grundlinien der Geologie von Bosnien-Hercegovina* (1880), p. 240.

‖ *Op. cit.* and also *Grundlinien der Geologie von Bosnien-Hercegovina*, p. 61.

¶ See H. Renner, *Durch Bosnien und die Hercegovina kreuz und quer*, 2te. Auflage (1897), pp. 325–354.

** "An Official Tour through Bosnia and Herzegovina," English edition (1890), pp. 273 and 325.

ravines, the contortions and overfolds in the Jurassic beds can be clearly traced upon the great rock-walls. The passage of fifty miles up the river lies almost entirely in the limestones; near its close, we come out abruptly on the Newer Cainozoic conglomerates of Jajce, which contain pebbles of the rocks that form the Karst. Here denudation has cleared out a sort of amphitheatre, at the head of which the town and castle stand. Part of this basin has been filled up by recent travertine, yet another type of limestone, which forms massive beds, cut through by the Vrbas and the Pliva. The Mohammedan town, climbing up a conical hill, is thus actually built on material brought in solution from the Karst. The modern waters are still adding to this deposit, trickling through the interstices of the tufa and forming new films and stalactites in the clefts.

Above Jajce, the wooded valley runs at first in the Palæozoic shales, which tend to pass into mica-schists. Now and then a brecciated limestone comes in, with faults and slickensided surfaces, and probably also of Palæozoic age.†† Palæozoic limestones are, indeed, bent up to form plateaux east of Bugojno, which repeat the characters of the great Karst-land to the west.

Between Donji Vakuf and Gornji Vakuf, two highly typical Bosnian villages, the elongated "polje" of Bugojno extends. The hills fall back on either hand, and here and there across the level cultivated land one can see the mouth of some gorge in the Karst, guarded by a ruined tower. In late Cainozoic times, when the basin came into existence, the streams from the limestone plateaux speedily converted it into a lake; but their clear hard water flowed through it, bringing down scarcely any matter in suspension. Consequently, the freshwater molluscs, *Limnæa* and so forth,‡‡ flourished in the lake, and their activity formed the fine chalky limestone, the so-called "shell-marl," that ultimately filled the basin. A true alluvium, deposited in modern days by the Vrbas, covers the central part of the area.

The road up this part of the valley has a very English air, gently winding between fine old hedgerows, which were planted in the Turkish days. Down among the willows, a man and his horse are bathing together in the stream, and the two figures are as simple and natural as a scene from prehistoric times. In a small field, three horses, tied to a post, run round and round, treading out the corn; while the winnowing is done, in a more open area, by a turbaned peasant, who flings up the grain with a shovel into the air. The stream shining in the sunlight, the life of the Bosnian homestead, the light wind blowing away the chaff, and the far-off piping of some herd-boy seated in the shadow of the woods—here you have the "polje" at its fairest, the oasis set against the Karst. Above Gornji Vakuf all this ceases; we plunge again into the beech-forests, and begin the ascent of the watershed between the Black Sea and the Adriatic, which has been chosen as the natural boundary between Bosnia and the rugged Hercegovina. The woods of beech and young oak cover the lower hills completely, but leave long grass-slopes on heights of five thousand feet or more. On the *col* of the Maklen Pass (1123 metres), there is a little clearing, and then we look out from the northern forest into a new and rock-girt world. The mountain-side drops steeply from our feet, and the Alpine road goes down in windings, like a white serpent, to the mosques and roofs of Prozor. The bare cliff of Triassic limestone on which we stand is succeeded by a park-like region, again due to the presence of Newer Cainozoic beds; but beyond and above this smiling foreground rise, tier upon tier, the craggy walls of the Hercegovina, culminating in the Prenj planina, 7000 feet above the sea. Seen from this distance, the country is clearly a huge plateau intersected by ravines. Beyond Prozor, we run abruptly into one of these gorges in the limestone. There is just room for the road in the notch through which we pass; then we swing down and down, curve after curve, into the great Rama vale below. Here we are lost among the rocks, driven onward, like the stream, along the one passage opened through the country; now and again, what looks like a knife-cut appears in the precipice on our left, where some tributary has worked its way down from the level highland of the Karst. The ravine, in the heat of a Dinaric day, is always deep in shade; at its foot, we run out into the still nobler valley of the Narenta, and halt for the night under the Prenj crags in an amphitheatre worthy of Tyrol.

Here the way is open to the Adriatic, through the great gorge that cuts across the Karst, past the barren slopes of Mostar, and down to the marshes of the Dalmatian shore. The sun beats upon the precipices, and makes each cirque a white furnace in the hills. The river itself shrinks among its stone-banks, leaving on its edges green and stagnant pools. The lizards, revelling in the noonday glare, lie motionless on gleaming slabs of rock; far up, one may see an eagle, sailing across the pale blue-purple of the sky. Perhaps it is time to turn northward, to cross the Ivan Saddle, and drop through the cool dark woods to Sarajevo.

†† Compare Mojsisovics, *Grundlinien*, &c., pp. 58 and 56.

‡‡ Mojsisovics, *ibid.*, p. 63.

ON THE RESPIRATION OF CERTAIN DRAGON-FLY NYMPHS.

By the Rev. ARTHUR EAST.

THE question as to the method of respiration amongst the various members of the family of the Odonata is admittedly an obscure one, and the following observations will, it is feared, not tend much to elucidate matters, but are intended only to draw attention to a point which does not appear to be generally recognised. That the question is one requiring careful investigation may be inferred from the following instance. One family of the dragon-fly group is furnished with certain leaf-like appendages to the extremity of the abdomen, which are known as the caudal lamellæ. These organs are closely connected with the tracheal system, no doubt acting in the same way as the gills of a fish, and extract the air dissolved in the water—in fact the nymph breathes by means of them. But of the three caudal lamellæ which these Zygopterid nymphs normally rely upon for supplying them with air, which is as essential to them as it is to us, often one, or two, or even all three are missing; lost to their owners by some untoward accident. Of one member of this group, Mr Lucas, in his book on the British dragon-flies, even writes that *Agrion puella*, as bred by him, *usually* lost its lamellæ before emergence, and yet, strange to say, the nymph appears quite as happy without its breathing apparatus as with it, and only suffers inconvenience, apparently, from the loss of its propeller, which function the caudal lamellæ also fulfil. It is believed that the process of breathing may be performed through the skin. A nymph recently placed in water, together with a small quantity of indigo, in order to see whether any stream of liquid could be detected entering and leaving the abdomen, as in the other chief group of the Odonata, was found to be stained with the pigment in the five last segments of the abdomen, the other segments, together with the head and legs remaining green, as before, but the proof that the pigment was drawn in by respiration through the skin was not by any means conclusive.

The other chief group of the Odonata perform the act of respiration in a different manner. The abdomen terminates in five more or less pointed appendages, two of them short and three longer.

In *Æschna cyanea*, a member of the Anisopterid group, two of these latter appendages are sharp spines, and are used as weapons of offence; the third, which is called the upper anal appendage, is somewhat obliquely truncated, and all three are grooved within, forming a minute channel when closed together. The effect of the upper anal appendage being truncated is that this channel, fine as a small bristle, is always open to the element the nymph is in, whether air, or water, even when the spines are quite closed.

Ordinarily these spines are kept wide open, and water is admitted to the interior of the abdomen and expelled therefrom by the regular dilation and contraction of the ventral side of the abdomen, the dissolved air being abstracted by certain folds in the last part of the intestine and distributed thence through the tracheal system.

The rate of breathing, which is very easily observed, varies from about thirty pulsations a minute to twenty, seventeen, or even thirteen a minute, the nymph at times remaining for several minutes at a time with all the anal spines closed, and without any perceptible dilation or contraction of the abdomen.

Now the fact of this anal channel always remaining open, even when the spines terminating the abdomen are closed tightly together, is connected with a very extraordinary faculty possessed by one at least, and possibly all, of the members of this group of the Odonata.

Of more than two hundred individual nymphs of *Æschna cyanea* observed, every one spent about the last two weeks of its aquatic life (minus the final two or three days) with the tip of the abdomen clear of the water, and the anal passage open to the air; when disturbed the nymphs would descend a short distance down the stick they rested on into the water, and return very shortly to their former position. During the two or three days immediately preceding emergence the position was reversed, and the head and thorax were protruded into the air as far as two large breathing apertures on the fore part of the body, called the thoracic spiracles. These spiracles under a lense could be seen to be open and they are connected with well developed tracheæ. This habit suggests very strongly that during the last fortnight of its aquatic life the nymph breathes the outer air direct into the tracheal system.

Being anxious to know whether this faculty is confined to the later nymph stages alone, the writer lately procured some nymphs of *Æ. cyanea*, about 1¼ inch long, and kept them out of water in damp weed, and the result is not a little surprising. Two nymphs have been living out of water for more than two months with only "short intervals for refreshment," and are as well and vigorous when put back into water as when first removed from it, and take their food with the wonted appetite of their kind; the intervals between visits to the water have varied from two days to twenty-eight days, and the times in the water have varied from two minutes to twenty hours; during its aerial periods the nymph is perfectly quiescent on the weed, and resumes its aquatic life exactly where it left off. Nor does this extraordinary faculty of living in both elements alternately seem confined to nymphs of which *Æ. cyanea* is an example.

Four nymphs of the Zygopterid group, viz., *Agrion puella*, have lived under similar conditions for thirty-three days without visiting the water at all, and appear perfectly vigorous and healthy. Similarly *Erythromma Naias* lived from March 16 to April 16 in damp weed only.

The present writer was led to investigate by the accident of leaving one nymph for some days in an empty bottle by mistake, and finding it well and hearty at the end of that time. It is true that this observation was only made on three species, but they are representative of both the Anisopterid and Zygopterid groups, and there is no structural reason why the same faculty should not be possessed by all the Odonata nymphs in an equal degree.

This faculty seems to be closely akin to that of the common crayfish of our streams, of which Huxley, in his "Introduction to Zoology," writes: "As is the case with many fishes, the crayfish breathes very well out of the water if kept in a situation sufficiently cool and moist to prevent the gills from drying up, and thus there is no reason why, in cool and damp weather, the crayfish should not be able to live very well on land, at any rate amongst moist herbage."

Consequently, the explanation that the nymphs breathe through the skin may, perhaps, be dispensed with, when the nymph is out of water, and true aerial breathing substituted. One's only regret is that thus the point would seem to be removed from one of Mrs. A. Gatty's most beautiful "Parables from Nature."

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor Alfred C. Haddon, m.a., sc.d., f.r.s.

V.—THE METAMORPHOSIS OF HERDERS INTO TILLERS.

In the article on "The Beginning of Agriculture" it was stated that a powerful constraint is necessary to force pastoral communities into the uncongenial occupation of agriculture. Again closely following M. Demolins I shall briefly describe how this constraint has been exercised upon two very different groups of herders. My French colleague has in his turn drawn upon the observations made on the spot by Le Play, and published in his "Ouvriers Européens," Vol. II., chaps. 1 and 8.

Environment.—The first locality selected for study is the village of Mochmet, which is situated on the eastern slopes of the Ural Mountains between Troitzk and Ekaterinburg, close to the great divide on the upper portion of the valley of Miask. Thus this village is located on the last of the Siberian slopes, and conversely is at the first point of contact with the sedentary populations of Europe. It is inhabited mainly by Bashkirs, who formerly were nomadic pastors, as their brethren still are on the neighbouring steppes.

Two conditions are necessary to enable a people to pass from a pastoral mode of life to cultivation of the soil:—1. The soil must naturally or artificially receive a sufficiently prolonged irrigation. As we have seen, owing to the short season of humidity, grass, practically to the exclusion of other vegetation, characterises the steppes; here numerous rivers and forests bear witness to the humidity of the climate. 2. The population must be constrained to become sedentary.

The neighbourhood of pastoral hordes is a permanent source of danger to sedentary peoples. The Russians, like the Romans of old and the French in Algeria with regard to the Arabs, remedy this by forcing the frontier nomads to become sedentary and agriculturalists. This is effected by the system of cantonment. No one is allowed to go beyond his canton on pain of death.

The process of cantoning consists in limiting the range of a horde and even in reducing it to till the soil. This modifies the pastoral life. The families begin to be less independent and self-sufficient. Soon they exchange the excess products of their flocks for domestic utensils and cereals in the great markets of Orenburg, Troitzk, etc. The introduction of cereals into every-day food is a forerunner of more important transformations.

Occupation.—The Bashkirs, as far as possible, retain the pastoral life, as during the five summer months, May to September, they live in tents. The main nourishment of the nomadic herders is furnished by mares' milk, and it is the number of these animals that constitutes a sign of wealth, but their number is greatly reduced.

All pastoral peoples exhibit a repugnance to other occupations. Two examples will suffice to illustrate this disposition. The pastoral mountaineers of the small canton of Uri, in Switzerland, could not be induced, even by high wages, to work at the St. Gothard tunnel, and Italians had to be imported. The Arabs in Algeria exhibit the same dislike to manual labour on the soil. The desire for wealth and the satisfaction of refined wants are not constraining forces in simple societies; they are rather artificial products, created slowly and with difficulty by a more complicated social state. What is natural to man is the love of ease and quietude.

The poorer Bashkirs who are obliged to subsist by agriculture or manufactures, go at least once a week to the tents to partake of the pleasures of kumis and exemption from agricultural toil, as well as for prayer and meditation in the beautiful country where the tents are pitched. How hard it is when winter arrives to descend to the village of Moehmet to be confined to a house and to live a sedentary life.

Work ceases to be attractive and the social conditions more complex. Two classes of family result: (1) the provident and (2) the improvident—*i.e.*, the greater number who have to be directed and maintained by the former. Thus we have an upper class and a lower class, and here we can trace the commencement of inequality among them. Hence the social problem arises of protecting the improvidents against their improvidence. These two classes are clearly marked among the Bashkirs. The one succeeds in maintaining and developing its first attempts at cultivation; the other, after vain attempts, falls back purely and simply to the wandering life of the pastors.

At first a pastoral people does not entirely devote itself to agriculture. The more improvident, as we have seen, live in their old state of life, while even the provident continue to rely as far as possible on the old habit of simple harvesting. The education of the agriculturist is a slow process.

Great variety of treatment is required in the cultivation of diverse plants, and the social consequences of varied tillage are very different from the uniformity impressed on the pastoral art. The Bashkirs employ those plants that necessitate the least amount of trouble and foresight. These are (1) hay for winter consumption, (2) vegetables, and (3) flax and hemp. They demand little time and labour, and all but the last two provide products immediately usable for the direct wants of the family. (1) Hay is the spontaneous production of the grass. (2) The vegetables require only easy work. The soil is abundant, rich, and well watered. The labour is performed by the women. A family possesses only two spades and a hoe, there is no plough. Seven days of work in a year suffices for the cultivation of a garden. They grow potatoes, turnips, carrots, onions and hops. (3) The cultivation of flax and hemp demands only five days' labour of the women, four days of the children and one day of a horse.

Many Bashkirs refuse to cultivate corn, because it gives too much trouble, but they have need of it owing to the diminution in milk. The work of the men occupies only twelve days, which are employed in the transport of the grain and other commodities.

Even this rudimentary cultivation demands more forethought and more resources than the pastoral art; for example, the stabling of the animals in winter and feeding them; the building of stables and barns; the hay must be got in rapidly and be properly preserved and of sufficient quantity to last through the winter. Then there is the cultivation of edible and textile plants.

A fixed house, as opposed to a tent, becomes necessary, fodder cannot be readily transported. Here the difficulties in the way of a fixed house are considerably reduced owing to the abundance of available land, the sufficiency of spontaneous productions, such as wood, etc., and the custom of *heummin*, or communal labour. This is an assemblage called together for a special purpose, such as carting, harvesting, building, and the like, the only reward being a copious feast at the end of the day and a distribution of brandy. This custom is a very widely spread one, and these communal operations form occasions for recreation and feasting. The *heummin* is an important social symptom, as it testifies that owing to cultivation, families, at least for certain works, can no longer as in pastoral societies suffice for themselves. They have to call in strangers, especially in the case of harvest, when on one occasion the provisions for the whole year are garnered. This is the first step along the road that leads to the introduction of hired labourers.

Property.—In the steppes the soil belongs to the community at large, the herder pitches his tents, and his flocks browse the pasture. Proprietorship lasts as short a time as the work. In agricultural communities the duration of work is prolonged. It takes several months, or even a year, before the recompense for the labour is attained. The prolongation of the duration of work necessitates the prolongation of ownership. This is the case with the Bashkirs, who have the least possible love for ownership of the soil. They take the minimum ownership; but, for all that, they remain several years on one spot. They do not annex property, it is the property that seizes and constrains them and which will not let them go. The duration of appropriation grows according to the exigencies of the labour. Among the Bashkirs the commune—still the sole proprietor of the soil—concedes to each family a portion of land for a period of fifteen years. Tacitus has recorded a very similar state of affairs for the ancient Germans, a mobile people but lightly attached to the soil. He says: "Land proportioned to the number of inhabitants is occupied by the whole community in turn, and afterwards divided among them according to rank. The wide expanse of plains makes the partition easy. They till fresh fields every year, and they have still more land than enough; with the richness and extent of their soil, they do not laboriously exert themselves in planting orchards, inclosing meadows and watering gardens. Corn is the only produce required from the earth."

Landed property tends to become more and more permanent. Le Play says that, among the Bashkirs, the arable lands and the prairies where they gather hay are allocated to the families, and they transmit them from generation to generation with definite limitations. However, the right exercised over this property by the family is more restricted than it is for the proprietors of the west, and still leaves a fairly large part to the right of the community. If portions of the land conceded to the families are not tilled during the space of several years those uncultivated lands revert to the community.

Landed property in becoming fixed is distributed by families, but not every family is capable of owning landed property. Among the Bashkirs the community gives each family a domain of which the greatest part is usually left fallow, because there is not the necessary aptitude for cultivating it. At the expiration of fifteen years the uncultivated land is reabsorbed by the community. The majority of the Bashkirs of Mochmet are in this case—they eliminate landed property from themselves, only the more provident remain proprietors. Thus there is a natural selection.

This return of unutilised landed property guarantees the possession of the soil to those who can cultivate it. The land cannot be alienated or mortgaged. Often even capable cultivators might be tempted to realise on land in order to pay numerous small debts, as happened when the serfs were suddenly put in possession of land in Russia and Hungary. On this occasion the majority of freed serfs were incapable of retaining it, and so a great deal of land fell into the hands of the Jews.

A distinction must be drawn between property in land and the property of the home. Landed proprietors comprise the more provident individuals, the best trained to work, to economy, to the position of masters. It is the race of true small farmers, the men of the country, strongly attached to the land, and who form the solid foundation of society. The proprietors of homes and their immediate dependencies with garden and orchard comprise the less provident individuals only capable of owning a property corresponding to their daily needs.

The Family.—Cultivation of the soil does not necessitate any essential modification of the organisation of the patriarchal family, and it maintains the moral effects of this form of family, the spirit of tradition pushed to routine, respect for pastoral authority, the pre-eminence of the old men, and social stability or rather immobility.

Certain functions, however, are henceforth fulfilled by agents outside the family; these are (1) religion, (2) the intellectual training, (3) government. In the isolation of the nomadic life these three functions were, like all the others, fulfilled by the patriarch. But these three functions are not essential to the paternal authority; they can be removed without diminishing anything of the essential function of a father, which is the government of the family.

The Bashkirs are Musulmen, and the Mullah of Mochmet performs in the mosque the ceremonies of his religion that relate to the birth, life, and death of his flock and to the sacred days of Islamism. He also acts as adviser, arbitrator, and often as judge. He teaches the young of both sexes, he even renders aid in sickness.

Government.—As to government, three causes contribute to lessen the paternal authority:—

1. The necessity of administrating and allocating the communal ground. This necessity does not exist in the steppe, for grass requires no administration, but in settled communities the land has to be partitioned out. The distribution of land is made by the assembly of the inhabitants, presided over by the Vuiberni, a sort of mayor of the commune. The Vuiberni is, after the Mullah, the richest person in Mochmet: he has four wives, and possesses six mares and four cows.

2. The obligation to construct and maintain the necessary buildings for religion and instruction. This is another consequence of a settled condition of life, and requires the combined action of all the families of the community, and it implies the payment of the instructor.

3. The necessity to provide for the public peace. As families congregate in a limited area misunderstandings arise, and disputes have to be settled by the intervention of a superior authority. Further, the neighbourhood of nomads is a source of perpetual conflicts—all border countries between steppes and cultivated land develop a race of nomad robbers. Each family cannot defend itself against the raiders, hence a public force has to be constituted, which is supported by a levy, according to circumstances, of recruits, horses, or money. A simple form of government regulates the public affairs of the community.

Although the soil is allocated by the Vuiberni the communal forests are under the charge of a Russian official. In Switzerland the forests of each canton are inspected by federal officers, the same obtains in France, otherwise the forests, which really are the accumulated wealth of the community, would fall a prey to the improvident.

Thus the law of property varies according to the nature of the chattels. The land may belong to everybody, cultivated land to provident families, the management of forests only to the most capable or to a stable government.

A study of even a small people may thus illustrate the social transformation due to the sole cause of a substitution of cultivation for pastoral life.

Work becomes hard and exercises restraints. Property is restricted and is possessed by the most provident families. The family is shorn of some of its functions. Special representatives of religion and education are elected. Government arises.

What has produced these great changes? Is it intense cultivation made over large areas? No; it is the most rudimentary of all cultivation—a simple gardening; the growing of a few potatoes, turnips, carrots, and onions!

ASTRONOMY WITHOUT A TELESCOPE.

By E. Walter Maunder, f.r.a.s.

IX.—AURORÆ.

It is an old saying, of the truth of which we are often reminded by our daily experience, that what is everybody's business is nobody's business. Work which someone is obliged to do, or is paid to do, gets done. Work too which is only open to a few to undertake also generally finds that some of that few will undertake it. But that which is open to everybody and yet to which no one is appointed, nobody driven, hangs fire and is left undone.

To take one example, one of the very earliest achievements of astronomy was to determine the length of the year. This was done long ages ago, earlier than we have any record. But it was a necessary or at any rate a very practical and useful work, and consequently was done at an early epoch. Take again a modern instance—the observation of double stars. This is a work which is by no means within everybody's reach. A powerful telescope, well mounted, clock driven, and furnished with a good micrometer, is the luxury of the few. But in spite of, perhaps we should rather say because of this restriction, double star observation has always found a number of ardent followers. So that, although it is but 120 years since this branch of astronomy took its rise, it has already made a most amazing progress.

On the other hand, the various branches of naked eye astronomy, branches open to every one who had eyes to see and a good atmosphere, have been left almost unworked. The departments of meteoric and variable star astronomy are the only two in which great and substantial progress has been made, and in both cases such progress has been the work of the last few years.

There need therefore be no surprise that the study of auroræ has not yet received the attention which is its due. A certain progress has been made, and it has had some very earnest and able workers, but the "Astronomer without a Telescope" who should take up this subject would find that he was by no means a gleaner in a closely reaped field.

The points which have been established are of great importance. First of all, we know that though, strictly speaking, meteorological phenomena, auroræ have a close astronomical connection. They vary in number as observed in any given locality in accordance with the sunspot cycle. More than that, they are evidently in the closest sympathy with the disturbances which take place in terrestrial magnetism. The present time therefore is not a specially favourable one to attempt their observation in these latitudes, since they are practically non-occurrent in England at the sunspot minimum through one of which we are now passing. Yet just as magnetic storms have their greatest amplitude and occur most frequently near the equinoxes so it is with auroræ, and October is the most prolific month of the year.

Auroral observation demands, beside good eyesight, an observing station remote from the glare of towns and artificial lights. The stories are common enough of fire engines being turned out to quench an aurora, and, on the other hand, it has not seldom happened that a very mundane conflagration has passed muster for "celestial display." "In the Memoirs of Baron Stockmar an amusing anecdote is related of one Herr von Radowitz, who was given to making the most of easily picked up information. A friend of the Baron's went to an evening party near Frankfort, where he expected to meet Herr von Radowitz. On his way he saw a barn burning, stopped his carriage, assisted the people, and waited till the flames were nearly extinguished. When he arrived at his friend's house he found Herr von Radowitz, who had previously taken the party to the top of the building to see an aurora, dilating on terrestrial magnetism, electricity, and so forth. Radowitz asked Stockmar's friend, 'Have you seen the beautiful Aurora Borealis?' He replied, 'Certainly; I was there myself; it will soon be over.' An explanation followed as to the barn on fire. Radowitz was silent some ten minutes, then he took up his hat, and quietly disappeared."

Granted the suitable position the most important consideration for the student of auroræ to bear in mind is the absolute necessity for keeping as systematic a watch as possible. The general agreement between the cycles of sunspots, of magnetic variation and of auroræ is clearly established, but there are many questions arising as to the connection between their minor fluctuations. Now the observation of the magnetic elements is perfectly continuous. Self-recording magnets are set up at many observatories, and supply us year in and year out with an unbroken register. Our record of the state of the sun's surface is practically continuous also, but from the nature of the case auroræ cannot be presented in the same manner. The chronicle is broken by the intervention of cloudy nights. It is weighted by the difference in length of darkness between winter and summer. Further, it is difficult to express our auroral observations on a perfectly uniform numerical scale. One year may have a poor record, either because auroræ were actually rare, or because the observer was remiss or the weather unfortunate. Another year may present a fallacious appearance of abundance simply because the observer was more diligent or more lucky in the circumstances of his observations. In a word, the accidental errors of the work are large, and it therefore becomes the first duty of the student to keep his own personal part in the matter as systematic and as free from accident as he can.

This is the first essential, and the observer therefore should draw up a scheme for himself for the examination of the sky at certain definite hours, and for certain fixed intervals, to which he should adhere with the greatest possible regularity. There is no need for him to make any great inroad into the ordinary hours of rest, as the meteoric observer must do, or that his watches should be very prolonged. It will be sufficient if they are perfectly regular.

It is much to be desired that auroral observers should be scattered as widely as possible, that we may be able to present not merely the auroral conditions for a single place, but for the entire planet. It has already been discovered that they are most frequent in two zones, one in the northern and one in the southern hemisphere, and that these zones shift their position with the progress of the cycle. In mid-latitudes as in England auroræ are most frequent at the time of the sunspot maximum. They retire polewards as the sunspot frequency declines, and are most frequent in high latitudes at the sunspot minimum. The place of the observer, therefore, is not a matter of indifference. A broken record in England cannot be pieced out by observations in the Shetlands or in Iceland.

But the value of a regular system of observations carried on at a single station for many successive years is very great, and we cannot have too many observers in the field.

After the mere fact of an auroral display has been noted, its duration and its average brightness are points to record. The duration, of course, is a simple matter; the brightness is more difficult, but a careful watch upon the auroræ of a rich year will enable the observer to draw out a rough scale for himself, which will satisfy the possibilities of the case.

An important detail in auroral work is the fixing of the position of some specially bright point from two or three fairly distant stations with a view to the determination of its height. This can obviously be best done by reference to the stars if many of these are visible at the time. It would, however, be well to have at hand some rough and ready means for obtaining the altitude and azimuth of any given point, and for this it would be easy to make a sort of rough wooden theodolite or altazimuth with a bar carrying a big easily seen pair of sights upon it instead of the telescope. As the auroral flashes come and go so quickly the time of any such determination must be taken with jealous exactness.

The value of having some means always at hand, however rough, for determining the position of an auroral beam, together with the need for exactness in giving the time of the observation, was well illustrated by the remarkable auroral beam of 1882, November 17. A great sunspot, the largest visible for eleven years, was nearing the central meridian of the solar disk. The magnet, which had been uneasy from the time of the first appearance of the spot at the east limb, began to be seized with the most violent convulsions about two hours before noon on the 17th, the disturbance lasting till 6 o'clock the following morning. "Strong earth currents were also observed at all the times of magnetic disturbance, varying in magnitude with the intensity of the magnetic changes, and the most violent electric storm recorded for more than thirty years swept over Europe and America." In sympathy with these manifestations a superb auroral display was witnessed on the evening of the 17th, but by far the most unique and striking phenomenon occurred "at about 6 p.m., when a bright beam of light rose from the eastern horizon and passed majestically across the sky in much the same manner as any ordinary celestial body might do, but with several hundred times their rapidity." Some twenty-six observations of the phenomenon were collected together by Mr. Rand Capron, but most of these were very incomplete, and their discussion was therefore attended with much difficulty, yet imperfect as the observations were they seemed to show with considerable probability that the height of the beam was 133 miles, and its speed about 10 miles per second. The direction of its flight was from east to west, magnetic not geographical. Had three or four of the observers but possessed some simple means for measuring the height of the beam at its culmination and the azimuths of its rising and setting, the precision of these conclusions would have been greatly increased.

The same charts that are useful for meteor observations may very conveniently be used for auroræ, the positions of the streamers or of the auroral crown being sketched in with reference to the stars. In all the work the first thing to be aimed at is to make the record as definite as possible. It is here that the difficulty of auroral observation is most felt. They are beautiful and impressive as spectacles, and the student will need no instruction in the preparation of his general descriptions. But to pick out the particular phenomena to which the desirable amount of definiteness can be ascribed will require practice.

From time to time curious beams of light are seen in the sky the exact nature of which it is difficult to determine. Thus on March 4, 1896, a curious light was seen stretching up from the horizon towards the Pleiades which some observers were inclined to regard as auroral, some as the Zodiacal Light, and some actually regarded it as being cometary. The fact that an unmistakable aurora was seen the same evening pointed strongly in favour of the auroral theory. On the other hand, as its direction coincided nearly if not precisely with that of the axis of the Zodiacal Light, and as similar beams have been seen in the same position on other occasions, the question cannot be regarded as absolutely decided. It would be a matter of the highest interest could it be shown that certain definite regions of the heavens were subject to recurrent flashes, and a careful collation of observations made at widely separated stations would soon settle as to whether we should regard them as auroral or zodiacal, and could not fail to increase our comprehension of one or the other phenomenon.

DARK MARKINGS IN THE SOLAR CORONA.

By W. H. Wesley, F.R.A.S.

Everyone who has examined a series of photographs of total solar eclipses is familiar with dark rifts or gaps in the corona. Most conspicuous at times of sun-spot minimum are the polar rifts, which at such periods open widely and occupy a considerable portion of the sun's polar regions. Rifts, more or less dark, also occur in other parts of the corona, sometimes sharply cutting into the densest portions. There can be no doubt that these rifts are merely interspaces between coronal rays. They show the extremely irregular manner in which the corona is distributed over the sun's surface. In view of the fact that the corona, whatever it may be, is not flat, as it appears during an eclipse, but is an object possessing three dimensions, it is obvious that a sharply defined rift, cutting into a dense portion of the corona, and traceable to the sun's limb, represents a gap of most singular form.

But striking as are these coronal rifts, there is a still more interesting class of dark markings that in many cases cannot be explained as mere interspaces among the bright rays. Unlike the ordinary rifts these dark markings are only occasionally seen. A close examination of the original negatives is often necessary to detect them, and as a rule they are lost in any photographic reproduction.

The first instance of their occurrence of which I know was in 1871. On the eastern side of the corona, in the

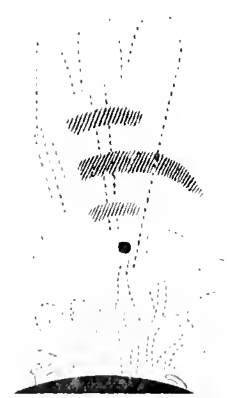


Fig. 1. Diagram of Markings on the Corona of 1871.

equatorial region, there appears on the photographs a small dark spot about 9' from the sun's limb. It does not occur near the crossing of any coronal rays, in which situation such an object might possibly be simply an interspace, but appears to encroach on bright rays. Morever, it is the centre of three arcs of circles, concave towards the sun, with radii of 3′, 6′, and 10′ respectively, the middle one being fairly strong, while the others are excessively faint. These singular appearances were thought by Mr. Ranyard to indicate the existence of a comet, showing as a dark object on the background of the corona; but as to this I pass no opinion. If it was a comet, its appearance was unique, for the comet on the negatives of the 1882 eclipse, and the much fainter one found by Schaeberle on his photographs of the eclipse of 1893, were both bright objects. But in any case it seems impossible that the dark spot and concentric arcs on the corona of 1871 can be interspaces between rays, for the arcs actually cut through several coronal rays almost at right angles, partially obliterating them. The whole appearance is extremely difficult to see, but I have traced the dark spot and the arcs on several negatives of two different series, and am certain of their existence.

The next example of dark markings occurred in the corona of 1896, the eastern side of which exhibited

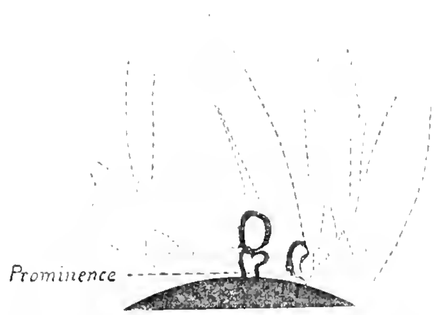


Fig. 2.—Diagram of Markings on the Corona of 1896.

features of a different kind to any I have examined. I will, however, refer only to those bearing on the subject in hand. Almost at the sun's equator is a bright double-headed prominence, which is distinctly *outlined* by a strong dark line, following all its contours. A little to the north is a small hooked coronal ray about 2½′ high, apparently springing from a small prominence. This ray is also outlined in the same manner. But by far the most extraordinary appearance is that of a dark roughly elliptical ring, about 2½′ in its longer axis, which stands on the top of the bright prominence. From the summit of the ring springs a fairly bright, fine ray, which would probably be traceable further down towards the limb but that its base seems cut off by the ring. There are many other dark streaks in this part of the corona, but we may confine our attention to the most striking features—the outline to the prominence and the ring. They are clearly seen on at least two of the negatives taken by Mr. Shackleton in Sir G. Baden-Powell's expedition to Nova Zembla, and, unlike the markings on the corona of 1871, they are quite easy to see under suitable conditions of illumination. A little reflection will convince anyone that the *outline* can be due to no known photographic effect. The image of a bright object (such as a bright prominence) may spread itself on the plate, and thus appear enlarged, or it might conceivably be surrounded by a halation ring, though I feel sure that the exposures during eclipses have never been nearly sufficient to cause such a ring round a prominence. But neither of these well-known photographic effects will explain the appearance in the least. Had an observer *drawn* the dark outline surrounding the bright prominence, we should have concluded at once that it was a mere effect of contrast, but the camera is fortunately not influenced by contrast. Is it possible that the prominence had edges enormously brighter than its centre, so that the dark outline is a phenomenon of reversal? This is improbable in the last degree, in view of the small aperture of the instrument and its considerable focal length; there was also slight hazy cloud, and the plates generally show no signs whatever of over exposure; their definition is admirable. There are many instances of reversal of the images of prominences in 1882, 1893, 1898, and 1900. In 1882 their centres were reversed, but there has been no case of reversal of their edges. Besides, the hooked coronal ray is also outlined, and that was certainly not bright enough for reversal, so this explanation breaks down. Then we have the elliptical ring, for which there seems absolutely no explanation, except that it is really a dark marking of some kind. It is surely absurd to suggest that it can be a mere space between coronal rays; we should have to imagine a tunnel cut through the body of the corona, directed precisely in the line of sight, and a plug of coronal matter lying along the centre of that tunnel but not touching its sides.

It will be seen that in the above cases the argument for the objective existence of dark markings is based upon the form and character of the markings, and not upon their actual darkness. Neither in 1871 nor in 1896 are they nearly as dark as the sky; but have we any instances of markings in the corona that are actually *darker* than the sky? If so, it appears to me that their objective existence is proved beyond a doubt. I believe we have such evidence, but here great caution is required, for although the camera is, as has been said, unaffected by contrast, the eye which examines the photographs is much affected by it, and we may be very easily deceived.

I have before me two negatives of the eclipse of 1898, taken by Mr. F. Bacon at Buxar, near Benares; they are rather over-developed, the lower portions of the

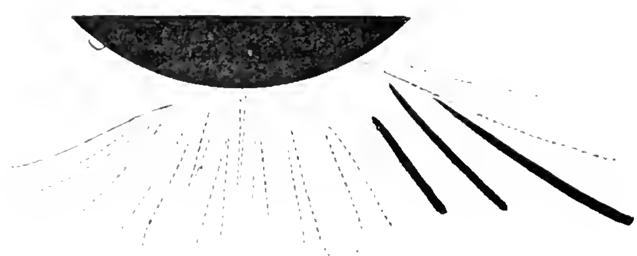
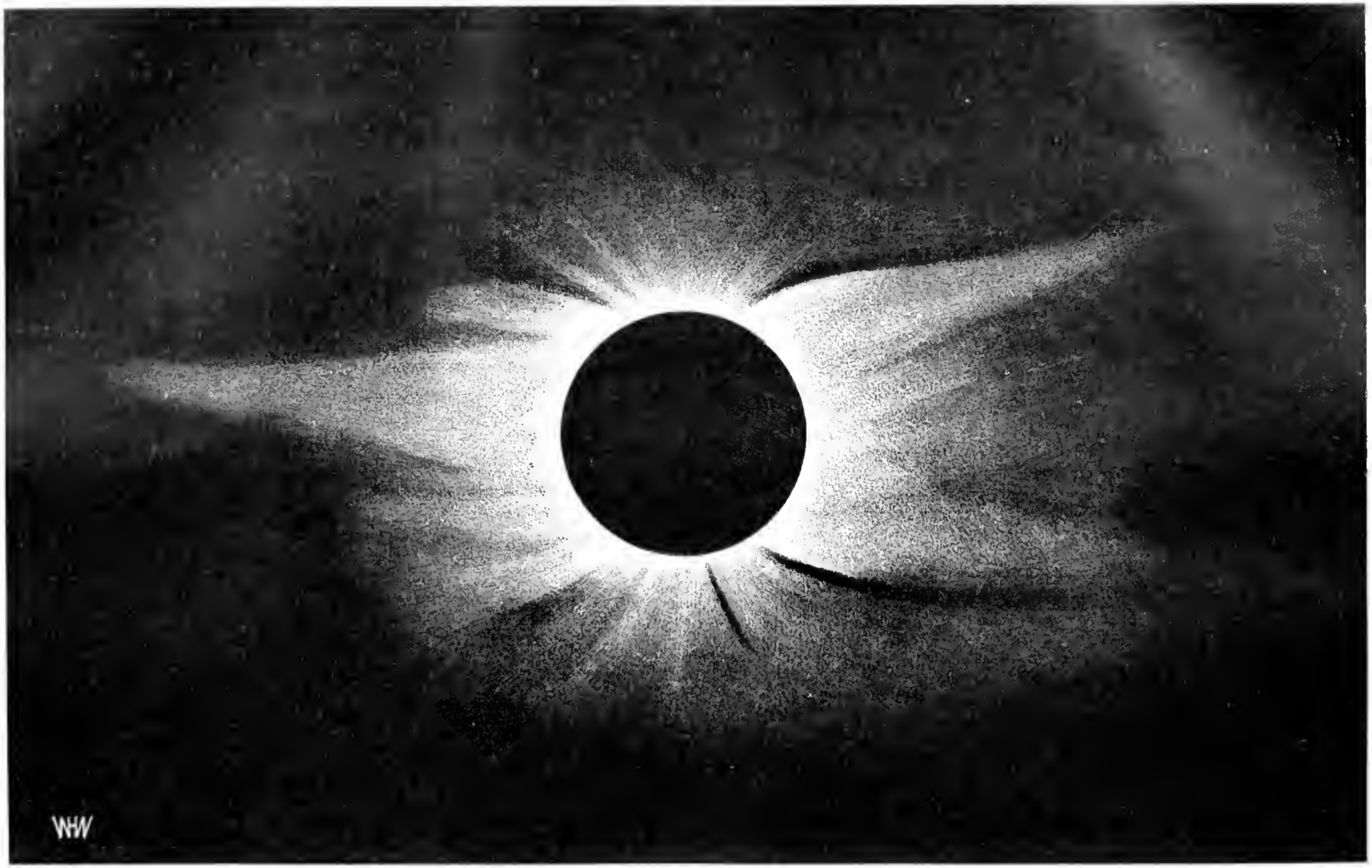


Fig. 3.—Diagram of Markings on the Corona of 1898.

corona are extremely dense and opaque, but the focus is excellent, and the outer portions well shown. The scale is a little over half an inch for the moon's diameter. On first looking at these I was struck by the unusual sharpness of definition of some of the rays of the great southern rift; but on more careful examination with various illuminations it seemed possible that this sharp definition is due to nothing less than to two or more fine dark rays (of course bright on the negative) lying between some of the bright polar rays near the western boundary of the polar rift. There is nothing un-

NORTH

EAST



WEST

SOUTH

THE CORONA OF 1900.

Drawn by Mr. W. H. WESLEY from Mr. MAUNDER'S Photographs.

usual or extraordinary in the position of these dark rays. I at first considered them to be merely spaces between the ordinary polar rays, but I now think that they are slightly darker than the sky. The development has been carried far enough for the light of the sky to impress itself on the plates; but for this fact the markings would appear simply as interspaces, but on these plates I think I can just see the ends of the rays, terminating at about two-thirds of a lunar diameter from the limb. They cannot be traced to the limb, as they are lost among the mass of bright rays, and they are lost in long exposure negatives. These markings are far more difficult to see than those in 1896, but if they are, as I think, darker than the sky, we seem to have taken a considerable step towards proving their objective existence.

We now come to the negatives taken by Mr. Maunder at Algiers during the eclipse of May last. On two negatives taken on Sandell plates with very long exposures, and on a series of negatives exposed by Miss Maunder with ½ sec. exposures in a stationary camera, are certain dark streaks of much the same character as those of 1898, but unlike these, they are most easily seen, in fact on some of the plates they strike the eye at once. One of them forms a sharp boundary to the northern edge of the western equatorial streamer, and one bounds in the same manner its southern edge, while another radiates from the limb near the centre of the great southern rift; there are several others that may be suspected. The only point in doubt is whether they are unusually definite spaces or rifts between bright rays, only seeming dark by contrast, or whether they are actually darker than the sky. If they are darker than the sky we seem forced to admit that they are real, however impossible it may be to offer any physical explanation for their existence. We cannot isolate these fine, narrow dark streaks, so as to avoid the effect of contrast. They are visible on all the six plates of the short exposure series, and the dark markings forming the north and south boundaries of the western portion of the corona are very strikingly shown on the long exposure negatives. These dark rays bounding the coronal extension are extremely remarkable, and it seems impossible to regard them as effects of contrast. For while on the one side they are each bounded by the edge of the coronal streamer, there is apparently no ray bounding them on the other side, and they appear to extend beyond the coronal streamer itself. If this is so, they are obviously darker than the sky, or the faint nearly uniform light which forms their background.* The dark marking bounding the southern edge of the western coronal extension is the most conspicuous.

The narrow, slightly curved dark ray near the centre of the southern rift, is well shown on the short exposure negatives. It has a distinct termination at a distance of about half a lunar diameter from the limb—a termination in fact more definite than those of the bright coronal rays. It seems decidedly darker than its background of sky or faint coronal light. If this marking is merely a rift, or interspace, it must be a rift *closed at its outer extremity,* which appears a most improbable supposition.

I am quite unable to offer any explanation of such features as these, but I think we cannot resist the evidence for their reality. As Mr. Maunder has said, they must be caused "by the interposition of actual dark absorbing matter between ourselves and the general diffused coronal glow"; so that the corona appears to be "not wholly an emission, but partly an absorption effect." The nearest analogy to them are the thick rays in the prominences to which Trouvelot drew attention, and which I believe Mr. Evershed has confirmed.

I have just examined some excellent negatives taken by Miss Bacon at Wadesborough, U.S.A., which clearly show the dark markings visible on Mr. Maunder's plates.

[The eight photographs of the 1900 eclipse to which Mr. Wesley refers in the above paper were as follows:—Two taken with a Dallmeyer stigmatic lens, 1½ inch aperture and 9 inches focal length, on Sandell triple coated plates, and six with a 4 inch lens, presented to the British Astronomical Association by Mr. G. E. Niblett, of the Royal Observatory, Greenwich. Focal length, 34 inches. Plates—Imperial, Extra rapid Ordinary, and Fine grain Ordinary.—E. Walter Maunder.]

* It is probable, as Mr. Maunder has pointed out (Knowledge, August, 1899), that there is a considerable amount of diffused coronal light beyond the limits of the detailed corona. This appears to be borne out by Prof. Turner's photometric measures of the negatives of the eclipse of 1898.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

ASTROLOGY.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Referring to your Editorial note to my letter in the September number of Knowledge, permit me to express my opinion that there is something to examine in astrology, and that though it is possible that astrologers were and are self-deceived, they are most decidedly not impostors. They do not go on blindly accepting the old teachings, but do their best to rectify and allow for any irregularities they may discover. "Astrologers can neither tell when or how the special 'influences' supposed to reside in each individual 'planet' or 'house' were determined, nor give the observations upon which primitive astrology was based" because thousands of years have elapsed since these data were established, and we have, like astronomers, no traditions or records to guide us, but it is only fair to assume that the early star-gazers were led to compare the planetary motions with events until the present system was formulated, possibly in Sumers-Akkadia, Hindustan, or Egypt, who can say?

You say in your remarks "The ancients recognised but seven planets, whereas there are—according to modern astrologers—nine. That is to say, in the opinion of the ancients Uranus and Neptune had no influence, for they never detected anything wrong in their calculations, as they should have done if these planets were really potent." It cannot be denied that modern astrologers do ascribe influences to Uranus and Neptune. They, however, agree that the influence of Neptune is reduced to almost *nil* by his great distance, and that Uranus only affects when in positions astrologically powerful for a similar reason. It is true, however, that in some instances, when nativities have happened at these periods at a time when the existence of this planet was unknown, the astrologer has found his predictions to a certain extent falsified in subsequent events, but these cases are exceptional. On the whole the ancients could prognosticate very satisfactorily without having any knowledge of Uranus, as his influence is only very obvious on rare occasions, and most probably the astrologer would at these times attribute his failures to irregularities or mistakes in his calculations, or to some slight variation in the planetary influences

The power ascribed to Uranus has been arrived at by the carefully rendered judgment of the leading astrologers upon the aggregate observations and comparisons of the students of this science. Astrologers cannot tell whether there are planets beyond Neptune for the simple reason that their enormous distance would render them of none effect, if existing, and if there are any within Mercury's orbit they are too small to have any effect.

It may be asked if Uranus affects so little why should not Saturn have considerably less influence than is astrologically ascribed to it. To this it can be said that Saturn is much greater in mass and nearer in distance, and these are facts which must be considered, as the influence does "vary directly as the mass of the acting body, and inversely as the square of the distance.

240, Holloway Road, N., September 5, 1900. B. CHATLEY.

[Mr. Chatley writes so temperately that although the subject of astrology seems to me, except as a matter of folk-lore, to be one of utter worthlessness, I feel bound to briefly reply to him. I would not have him suppose that I consider all astrologers necessarily conscious impostors. Astrology itself is certainly a fraud, but many of its followers, in the present as in the past, have no doubt been perfectly honest.

Mr. Chatley says that the astrological influence of the planets does vary directly as the mass of the acting body and inversely as the square of the distance. Here he is distinctly at variance with all ancient astrologers, and I fancy with the great majority of modern ones. The masses of the planets have only been determined within the last 200 years. Their relative distances were of course known earlier, but neither distances nor masses enter into the construction of ancient horoscopes, and are certainly very often if not always omitted from modern ones.

Mr. Chatley has probably overlooked the fact that if it be true that astrological influence be subject to the same law as gravitation, then the sun is some five million times as potent as Mercury, and the moon is thirty thousand times; Jupiter one hundred and eighty times; Venus and Saturn only twelve and fifteen times. Mars will average as weaker than Mercury, and will have almost the same mean potency as Uranus; but though Mars will occasionally come into very effective positions for a considerable part of its orbit it will rank much lower than Uranus, and often be feebler than Neptune. The influence of Uranus, so far from being occasionally effective, will be very evenly steady.

I think then it is abundantly clear that the law of gravitation finds no place in astrology. Yet if we assume that the influence of the planets is irrespective both of mass and distance we shall find ourselves confronted by a more serious difficulty still.

It is, however, sufficient to take Mr. Chatley's own admission that the original observations, if there ever were any such, upon which the rules of astrology were based, have perished. These rules, therefore, are accepted nowadays simply in blind unreasoning faith, and therefore "astronomers do not care to waste time on an examination into astrology, for the reason that there is nothing in it to examine." E. WALTER MAUNDER.]

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Mr. E. W. Maunder does not appear to have got beyond the five senses in his criticism of Astrology, and I am quite certain from his remarks that he has never given the subject any serious study. The TRUE astrologer believes that the sun is the body of the Logos of this solar system, "in Him we live and move, and have our being." The planets are his angels, being modifications in the consciousness of the Logos. Astrology explains the harmony of the spheres, and a correct knowledge of its teachings must elevate and raise every individual consciousness.

It is very easy to pull down, but a far more difficult task to build up. If anyone chooses to call Jupiter malign, and Saturn benefic, as Mr. Maunder suggests, I will contradict him, and, what is more, prove it. You can settle any dispute with regard to the truth of astrology by accepting a test case, and publishing the result in KNOWLEDGE. But to convince a prejudiced person against his will is, I fear, a hopeless task, but I am willing to do all I can to prove that astrology is true and not false. ALAN LEO,

Editor of *Modern Astrology*.

9, Lyncroft Gardens,
West Hampstead, London, N.W.

[I did not expect so prompt and authoritative an acknowledgment that I was right in stating that astrology was only a survival of paganism. Mr. Chatley will see that Mr. Leo conclusively answers him. The physical sciences deal simply with the objects known to us by the five senses. If he is to be an astrologer on Mr. Leo's lines, he must leave the evidence of his senses behind. To such a demand men of science, and KNOWLEDGE in their name, can pay no regard.

E. WALTER MAUNDER.]

THE ZODIACAL LIGHT IN RELATION TO THE CORONA.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—As an amateur who in a humble way takes delight in the study of "Astronomy Without a Telescope," I read with much pleasure Mr. Maunder's article on the Zodiacal Light, and it occurred to me that this light may arise from the same cause and partake of the same nature as the mysterious light that plays about the moon's edges during a solar eclipse. This may seem bold for an amateur to suggest, but the thought carries reason with it when we reflect that every sunset is an eclipse of the sun—to the observer—that is to say, every time the sun sinks out of view the observer sees it being gradually eclipsed by the rising horizon; and every morning he sees the sun rise into view he sees the eclipse passing off.

Early astronomers held the opinion that the corona was due to the solar beams being refracted by the atmosphere of the moon, but modern investigators tell us the moon is devoid of atmosphere. In this case, by the way, why is the moon not battered out of existence by comets, meteors, and the various fiery fragments that scourge the heavens, seeing that the earth is protected by an atmosphere; and by what means (if these celestial batteries have been falling on its surface for countless ages) has it not become overweighted, lost its equilibrium, and fallen from its high sphere into the lap of mother earth? But admitting the moon to have no atmosphere: when we know that light is capable of being reflected from any body whatsoever, no matter how solid or rugged its substance may be, it is no great stretch of imagination to suppose that the solar beams, impinging on the rugged surface of the moon, will be broken up and dispersed in all directions, as the sea waves are broken up and scattered in foam when they dash against a rock-bound shore. This theory is not confuted, as may seem at first sight, by the appearance of the moon's dark body moving across the luminous area. We take it for granted that the rays of the sun in course of an eclipse are at all times focussed upon a given point of the moon's sphere, that point being in a direct line between the eye of the observer and the centre of the sun, and that said rays are dispersed within a given area describing a circle. Now, as the central point of the moon's sphere approaches coincidence with the central point of the solar orb, the increasing diameter of the moon will encroach on the circle of visible dispersion, and seem to pass across the face of the illuminated area. The extent of this luminous circle of dispersed light will vary—to the observer—and might be expected to increase in brilliance and in area in proportion to the decrease of direct light from the sun, until when complete coincidence takes place and darkness lies over the land a more or less concentric ring of light will result, extending far beyond the borders of the moon.

With reference to the analogy between this phenomenon and the Zodiacal Light it may be observed that before and immediately after the sun sinks below the horizon, to a beholder its rays are refracted solely by the earth's atmosphere; and cloud and sky assume an endless variety of beautiful and evanescent hues; but as the earth revolves on its axis, the beholder changes his position relative to the direction of the solar rays, which form an ever-widening angle with the observer's line of vision. This being so, is it not just possible that given a certain position for sun, earth, and beholder, the reflected light of earth and atmosphere together are projected upwards in the direction of the zenith, and become visible from the observer's standpoint after the darkness is sufficiently dense to show it up? This earth-shine anyone can see with naked eyes by examining a new moon. A Country Lad.

Galston, Ayrshire.

[A friend of ours having been shown the anatomy of a caterpillar under a microscope, exclaimed in wonder, "I never knew that a caterpillar had organs; I always thought it was only skin and squash." There might have been something in "A Country Lad's" suggestion, if either the Corona or the Zodiacal Light were mere shapeless glares of light. A single glance at the actual Corona, or the comparison of a few good photographs, would convince "A Country Lad" that it was no more an amorphous "squash" than a caterpillar is, but that it possessed a real and definite structure; a structure quite independent of "the rugged surface of the moon." It is a real entity; not a mere diffusion or refraction effect. So the Zodiacal Light, although much less definite, proves by the character of its motion amongst the stars that it too has an actual objective existence.

[E. Walter Maunder.]

"THE 100 BRIGHTEST STARS."

TO THE EDITORS OF KNOWLEDGE.

Sirs, In the article on the "Hundred Brightest Stars" there are several points I should like to ask about. I will number them.

1. No. 7 is given as "Rigel (α Orionis)" and No. 11 as "α Orionis." If the second "α Orionis" is Betelgeux it is given as "β Orionis" in my chart.

2. Should not the note on No. 2 read "does not rise"?

3. The note numbered 66 looks as though it belonged to Algol, 68.

4. In the list there does not seem to be a sharp line between the magnitudes as given on my little chart. Can you say on what plan or on whose authority these "rough" charts (my own is Philips' Star Maps) mark the magnitudes? L. Cuthbertson.

32, Sparsholt Road, Crouch Hill, N.,
September 12, 1900.

[1. No. 7, Rigel (α Orionis), is a misprint for β Orionis.

2. Yes.

3. 66 is a mistake and should read 68 (Algol).

4. The magnitudes shown on popular star maps are always more or less unreliable.—J. E. Gore.]

OCCULTATION OF SATURN ON SEPTEMBER 3.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—This phenomenon was witnessed here under the best of atmospheric conditions. I turned a 4-inch Cooke refractor on the moon at 6h. 35m., and with a power of 65 immediately saw Saturn a little east of the dark limb and exceedingly faint. Increasing the power to 235 I calculated the approach of the two bodies, and then the gradual encroachment of the moon's dark periphery upon the W. ansa, the ball, and finally the E. ansa. The effect was very picturesque and novel during the 110 seconds over which the disappearance extended. This interval applies to the time elapsing from the first observed flattening of the ring to complete occultation.

At reappearance the moon was much brighter in the darker sky, and the relative brilliancy of Saturn and the limb of our satellite afforded a notable difference. When the outer section of the ring emerged it was only just perceptible, being nearly obliterated by the intensity of the light from objects on the lunar margin. The reappearance of the planet occupied a shorter period than the disappearance, as it emerged at a different angle relatively to the major axis of the rings. When quite free the comparison of tint between the planet and moon was very interesting, the feeble leaden line of Saturn being in striking contrast with the vivid lustre of our satellite.

As the ball of Saturn was emerging from occultation I looked for a dusky band fringing that part of the moon's edge projected on the planet, but no such appearance could be discerned. A feature of this kind seems to have been occasionally noticed on Jupiter during occultation of that planet.

The times of first and last contact of the outer edge of Saturn's ring with the moon were very roughly noted by my watch, as 7h. 12½m. and 8h. 10m. About 15 minutes after the reappearance Saturn became distinctly visible to the naked eye near the S.W. limb of the moon. W. F. Denning.

Bishopston, Bristol,
1900, September 6th.

JUPITER.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I regret that in my drawings of Jupiter, published in the September number of Knowledge, the planet was shown with a circular instead of an oblate disc. My original figures were correct, but in the wash-copies made from them at your office for purposes of reproduction the shape was altered, and when examining the proofs I failed to notice the change, my attention being riveted on the markings. The responsibility for the mistake rests entirely with me, and no doubt it would have been rectified but for the very ill-health from which I suffered, and which made work very difficult for me at about the time I had the proofs. The shape of the planet as represented does not affect the general accuracy of the details shown, but the object ought to have been delineated in his natural figure, and I have thought it worth while to make these few remarks in explanation.

On September 3 I observed Jupiter with a 4 inch Cooke refractor, power 235, and found the hollow in the great southern equatorial belt, north of the red spot central at 7h. 10m., so the longitude of this feature was 44°.4, for it followed the zero meridian (system II.) of Mr. Crommelin's ephemerides 1h. 13.4m.

Bishopston, Bristol. W. F. Denning.
1900, September 6th.

Science Notes.

Among the new committees appointed by the British Association at Bradford is one to assist Mr. Vaughan Cornish in his investigation of terrestrial surface waves and wave-like surfaces. It will be remembered that Mr. Cornish contributed a series of articles on "Waves" to these columns in 1896, and he has lately received the "Gill Memorial" for his work in connection with the subject.

The following awards at the Paris Exhibition were made to British Scientific and Photographic Instrument Makers:—James J. Hicks, London, two gold, two silver, and four silver to employees; Cambridge Scientific Instrument Company, Limited, Cambridge, grand prix and silver—one gold and one silver to employees; Ross, Limited, London, grand prix; James White, Glasgow, grand prix; Negretti & Zambra, London, two gold; W. Watson & Sons, London, two gold; Newman & Guardia, Limited, London, gold; J. H. Dallmeyer, Limited, London, gold; Crompton & Company, Limited, London, gold; Kodak, Limited, London, grand prix; also to J. Defries & Sons, London, 2 grands prix; Smith-Premier Typewriter Company, London, grand prix.

Obituary.

We regret to record the death, on the 31st August, of Sir John Bennet Lawes, Bart., D.C.L., LL.D., F.R.S., our pioneer of scientific agriculture. He was born at Rothamsted in the year 1814, and educated at Eton and Oxford. At an early period of his life he succeeded to the family estates, and commenced the series of experiments which have since made him world famous. He discovered the value of bones for fertilizing the soil, but the process of breaking these up was a laborious one, and the fragments were long in being absorbed by the soil. In 1842, however, after many experiments in the field, a patent was taken out for treating mineral phosphates with sulphuric acid, and a small industry was commenced at Harpenden. The success of this undertaking led Sir John to enlarge the manufactory, and a place was selected at Barking. After many years of prosperity the whole business was sold for £300,000, thus testifying to the enormous value of artificial manures as fertilisers of the soil. In 1843, Dr. (now Sir) Henry Gilbert became associated with Sir John Lawes, and these two worked together for upwards of fifty years. It is impossible to indicate here the vast amount of work done by Sir John and his colleague, but the results of the investigations would form a complete history of scientific agriculture during the last half century. The memoirs published by these experimenters from the year 1847 onwards number 130, and include the results of a great many classical investigations on many such questions as wheat production, beet sugar manufacture, and the sources of the nitrogen of vegetation. The late Sir John was elected Vice-President of the Royal Agricultural Society in 1878, and a trustee in 1891; was elected a Fellow of the Royal Society in 1854, while in 1882 the Queen created him a baronet.

It is with great regret that we learn of the death, in San Francisco, on August 12th, of James Edward Keeler, A.B., SC.D., Director of the Lick Observatory and Astronomer.

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Re-introduction of the Great Bustard.—Whether the re-introduction of the Great Bustard in England will be a successful experiment or not it is at all events a most interesting one. Several Great Bustards have been imported and liberated on the borders of the Norfolk fens. "This effort is due," Lord Walsingham informs us, "to the public spirit of an English gentleman resident abroad." The introduction of creatures in a wild state into a country altogether foreign to them is from every point of view deplorable, but we shall all look forward to the success of this experiment to re-introduce the Great Bustard—once the pride of our indigenous avifauna.

The success of the experiment depends we are afraid in a large measure to the good fortune of the birds themselves.

How ever much may be done, and we are glad to say that much has been done, in publishing the facts about these birds, what will prevent their destruction if once they come within easy range of the ignorant villain who goes out to kill, no matter how, or what, as long as he can safely boast of it?

Let us hope that these bustards from a sunnier clime, but we are afraid no less barbarous country than ours, are amongst the wiliest of their crafty race, and will thus survive. We can hardly expect them to increase greatly, and become what they were a hundred years ago, for since then railways, roads, houses, trees and hedges, and a hundred minor things have grown up to bar their way and terrify their wild nature, where once stretched the great wastes and rolling plains they loved so well.

Great Crested Grebes in Richmond Park. (*The Field*, August 18th, p. 298.) Mr. W. R. Read records the interesting fact that for the second year in succession a pair of Great Crested Grebes have hatched out two young ones in Richmond Park.

A Short History of the Bearded Titmouse. By J. H. Gurney. (*Zoologist*, August, 1900, pp. 358–371.) This is an interesting account of the Bearded Titmouse, which is reduced in numbers in England to a mere remnant (although we are glad to say now an increasing remnant), confined to the Norfolk Broads. The author divides his account into the following heads: Distribution, increasing scarceness, habits, nidification, former breeding area, etc. Additional notes appear in the *Zoologist* for September, 1900, pp. 422 and 423.

A Visit to Lough Erne in Search of the Sandwich Tern. By Robert Warren. (*Irish Nat.*, September, 1900, pp. 220–223.) This is an account of the birds observed breeding about Lough Erne, and establishes the fact that the Sandwich Tern nests there. Hitherto the only known nesting place of this bird in Ireland was near Ballina, in County Mayo.

Notices of Books.

"Researches into the Origin of the Primitive Constellations of the Greeks, Phœnicians, and Babylonians." By Robert Brown, junior, F.S.A., etc., etc. Vol. II. (Williams and Norgate.) 10s. 6d. Just a year ago we reviewed the first volume of Mr. Brown's work on the Primitive Constellations, and it is with much pleasure that we note its continuance in the second and concluding volume. The second volume is in many ways an improvement on the first. Important though the first volume was, as a serious and practically a new investigation into the history and origin of the constellation figures, this volume, which is concerned entirely with the Euphratean star records, is more important and takes us into ground more entirely virgin still. Further, some of the faults which disfigured the first volume are less felt or have been corrected in the second; there is less reason to complain of those vain repetitions which led us before to think that Mr. Brown had become so enamoured of the principle of reduplication in the Zodiac as to conclude that there could not be too much of it in the pages of his books. Though the subject is newer and more difficult than in the preceding volume, Mr. Brown has handled it more clearly and invested it with greater attractiveness. The restoration of the Euphratean planisphere from three small fragments, which forms the subject of chapter IX., is of particular interest. The chapter on "Constellation Subjects in Euphratean Art" would be more convincing if it were not for the manifest assumption on Mr. Brown's part that any object, no matter how familiar, that the Euphrateans sculptured or engraved must necessarily be constellational if it chanced to be amongst the objects which they had chosen for the constellation forms. In the "Tablet of the Thirty Stars" there is a good deal that we find unconvincing. It is difficult to suppose that the original lunar zodiac, no doubt far earlier than the solar one, can have begun with the group of Alpha Aquarii. Chapter XIII., on the Celestial Equator of Aratos, deals with a subject which Mr. Brown has already treated fully elsewhere, but its great importance in the present connection fully justifies him in bringing it forward again. We note, too, with pleasure his very pregnant suggestion that the constellations probably began with the choice of single stars or of small striking groups; other stars being selected later as they happened to lie most suitably for connection with the original idea. He justly and strongly repudiates the suggestion that the natural configuration of the stars suggested the constellation figures. The idea has had some good names to back it, but a very little direct acquaintanceship with the appearance of the heavens is sufficient to disabuse any impartial observer.

When we come to the question, however, of the origin of the constellation forms, we find a grievous inconsistency in Mr. Brown's position. He cannot make up his mind as to whether the Zodiac took its origin when Aries or when Taurus was the equinoctial sign. He tells us indeed explicitly in more than one passage that the latter was the case; he assumes in a hundred that the former was. Both cannot be true. If he could but steadily lay hold of the fact, which is certainly astronomically established, that the constellations were originally mapped out, possibly in the Euphratean valley, but far north of Babylon, and many centuries before the equinox had entered Aries, it would cause him indeed to revise very much of what he has written, but its value would be indefinitely increased. The bearing of this fact on the solar myth is most important; it teaches us that the sun was not first personified as a Ram and the constellation then designed to accord with it, but that the constellation first received the name and figure of the Ram, and the sun derived its personification from the star group. We trust that Mr. Brown may be persuaded to provide himself with a good precessional globe, and setting it for about 5000 B.C., to go over the ground again, checking every conclusion by its aid. We have no doubt that it will materially modify his views in many details. Even as it is, we assuredly owe Mr. Brown a very heavy debt for the industry and ability with which he has pushed his enquiries into a region previously so entirely unexplored, and yet of such intense interest to all who concern themselves with the beginnings of the oldest and grandest of the sciences.

"Inorganic Evolution as Studied by Spectrum Analysis." By Sir Norman Lockyer, K.C.B., F.R.S. (Macmillan.) 4s. net. This volume may be considered as a sequel to the three works published in the preceding thirteen years "Chemistry of the Sun," "The Meteoritic Hypothesis," and "The Sun's Place in Nature." Its purpose is to gather together and focus the evidence presented in the three former volumes of the dissociation of those substances which we are accustomed to regard as elementary, and the entire array of observations and theories presented in the whole collection are regarded as a contribution to the study of the evolution of those elements. It is clear, therefore, that the book is one dealing with a subject of the highest importance, and it should be said at once that of the four volumes of the series it is by far the best.

The earlier chapters dealing with the first principles of spectroscopy are admirably clear, so clear as to give rise to the unkind suspicion when Sir Norman writes obscurely—and no one can surpass him in this respect at times—that either he has then no definite idea of what he wishes to say, or else no very strong desire that he should be understood. So far, too, as the present work summarizes the conclusions of the three earlier volumes, we find a considerable increase in precision.

As to the theory here put forward, that of the growth of the elements themselves, it is one of which it is very easy to vaguely formulate. It has been done repeatedly by men who are justly regarded as paradoxers as well as by some of the very leaders of science. Prout's Law, Mendeléef's Periodic Law, were quite sufficient to suggest it to any imaginative mind. But the working out in detail is a very different business, and to discuss adequately the details here given would require as much space as the book itself. Leaving the plausibility, therefore, of the theory entirely on one side, it is sufficient to say here that Sir Norman Lockyer gives a clearer account of the present state of the discussion, and a more precise exposition of his own views with regard to it, than in any of his previous works. He comes more nearly to committing himself to definite propositions which can be tested and refuted or confirmed. The book, therefore, will both be more useful to the student and a more valuable contribution to science than any of its three precursors.

The illustrations are, we regret to say, of the same unsatisfactory character as in the previous volumes.

BOOKS RECEIVED.

Text-Book of Zoology. Part II.—Birds, Reptiles, Fishes. By Dr. Otto Schmeil. (Black.) Illustrated. 3s. 6d.

Microscopes and Scientific Instruments—Catalogue, 1900–1901. (C. Baker.)

Elementary Physics and Chemistry. Gregory and Simmons. (Macmillan.) Illustrated. 1s.

Outlines of Field Geology. 5th Edition. By Sir A. Geikie. (Macmillan.) 3s. 6d.

Photometrical Measurements. By Wilbur M. Stine, PH.D. (Macmillan.) 6s. 6d.

A Treatise on Zoology. Edited by Prof. E. Ray Lankester. *Part II.—The Poripera and Cœlentera.* (Black.) 15s. net.

An Outline of the Theory of Thermodynamics. By Edgar Buckingham. (Macmillan.) 8s. net.

The Spectrum Plate. (Pamphlet.) By Miss Ackland.

The Path of the Sun, Illustrated by Diagrams. By William Sandeman. (Simpkin.)

The Journal of the Society of Comparative Legislation. August, 1900. (Murray.) 5s.

Studies in Fossil Botany. By Dr. D. H. Scott, F.R.S. (Black.) Illustrated. 7s. 6d. net.

On the Rotation of Spiral Nebula Messier 51 Canum Venaticorum; Annual Report, 1899–1900, Savilian Professor of Astronomy; and other astronomical pamphlets. By H. H. Turner, Savilian Prof. of Astronomy.

The Birds of Ireland. By Richard J. Ussher and Robert Warren. (Gurney & Jackson.) 30s.

WIRELESS TELEGRAPHY.—IV.

By G. W. DE TUNZELMANN, B.SC.

ELECTRIC WAVES.

As far back as 1842, the American professor, Joseph Henry, pointed out that the phenomena accompanying the discharge of a Leyden jar suggested that it was of an oscillatory character; and Helmholtz, in 1847, in his celebrated essay on the Conservation of Energy, made the same assumption, and pointed out that the oscillations would become continually smaller until the entire energy was dissipated by the opposing resistances. The time of a complete oscillation, as mentioned in my first article, is

$$T = 2\pi\sqrt{LS},$$

where L and S are the self induction and capacity of the circuit respectively.

The meaning of these electrical constants will be more clearly understood by a comparison of the electrical oscillations with mechanical oscillations of a simple character such as those of a straight spring fixed at one end and having a weight attached to the other.

The flexibility of the spring is the analogue of the capacity, and the inertia of the loaded spring that of self induction. An increase in either of them will diminish the rate of oscillation. In the electrical case the capacity of the circuit may be increased by making the jar larger, and as the self induction is due to the magnetisation of the medium surrounding the current it may be augmented by increasing the length of the circuit. Owing to the fact that there is very little magnetising effect, except close to the conductor, the area included in the circuit makes very little difference, so that the circuit may be wound into a coil, making the arrangement more compact. If the oscillations were slower the self induction might be still further increased by filling the space inside the coil with iron, but with these extremely rapid oscillations the iron is protected from magnetisation by the currents, opposed to those in the coil, which are induced by the latter in the outer skin of the iron, and the result is that the introduction of iron does not increase the self induction but actually diminishes it.

When the spring is set in motion the vibrations rapidly die away. This damping action is caused by the friction of the different portions of the spring, the energy of vibration being thereby dissipated into molecular vibrations or heat. It may be increased still further by immersion in a viscous medium, and if sufficiently viscous the motion may become *dead-beat*, that is to say, simply a single excursion and return to the position of equilibrium. Another cause of damping is the transference of energy to the medium by the production of waves in it, and if the spring is so shaped as to increase this effect the damping will also be increased. The electric oscillations which occur when a Leyden jar is discharged are damped in a very similar manner, the resistance of the circuit corresponding to friction, in the case of the spring, but in order to destroy its oscillatory character, except in the case of very large condensers, such as are used in submarine telegraphy, it is necessary to include in the circuit some very bad conductor, such as a wet string or a block of wood. The rapid damping of the oscillations of a Leyden jar discharge when the circuit is so designed as to be an efficient exciter of electric waves follows necessarily from the principle of the conservation of energy, just as in the case of the spring.

The Hertz oscillator, or exciter of electric waves, is simply a Leyden jar of such design as to facilitate the transference of the energy of the electric oscillations of its discharge to the surrounding ether, and therefore a comparatively large amount of energy is required to maintain it in action. Several years before Hertz's experiments were made, Professor Fitzgerald, of Dublin, had suggested, from theoretical considerations, that it should be possible to excite such electric waves in the ether by means of the discharge of Leyden jars of suitable design, and about the same time that Hertz began these investigations Professor Oliver Lodge was, in connection with the theory of the lightning conductor, making a series of experiments on the discharge of small condensers, which led him on to the observation of ether waves within the wires, and not waves transmitted by the material of the wires themselves.

As Hertz himself suggests, Professor Lodge would in all probability have succeeded in discovering the ether waves in air had he not anticipated him.

Hertz tells us that in 1886 he was experimenting with a pair of what he calls Riess or Knochenhauer spirals, but which should be more properly called Henry spirals, spirals of silk-covered copper tape first used by Professor Joseph Henry about 1838 in his researches on mutual and self induction. Hertz noticed that in order to obtain sparks in one of these spirals the large batteries which had hitherto been employed might be replaced by even a small Leyden jar, provided—and this was the important point—that the discharge was made to spring across a spark-gap. This observation led to the splendid series of researches which experimentally demonstrated the truth of Maxwell's theory of electromagnetic waves, and laid the foundation for the method of telegraphy which Signor Marconi and others have so successfully developed into a practical system.

It is well known to musicians as well as to students of acoustics that when a certain musical note is sounded, a string or pipe which would give out this note will respond to it, and in a similar manner an electric conductor may be adjusted or tuned to respond to the

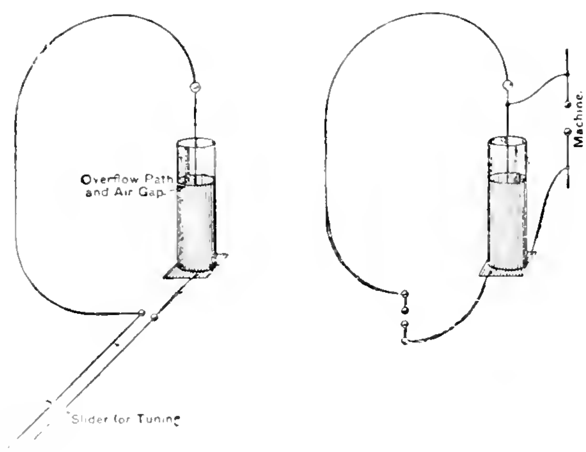


FIG. 1.—Lodge's Experiments with Syntonic Leyden Jars.

From Lodge's "Signalling through Space without Wires."

oscillations set up by the discharge of a Leyden jar. This is well shown in an experiment made by Professor Lodge after reading Hertz's papers. He took a pair of Leyden jars (Fig. 1) with circuits about a yard in diameter, and separated by a distance of about two yards, and found that when the first jar was charged and discharged the waves set up in the second circuit could be made to cause it to overflow across a short air-gap, provided by pasting a slip of tinfoil over the lip of the second jar, by experimentally adjusting the slides shown in the illustration. Lodge calls this syntonising the pair of jars. A closed circuit such as this is a feeble radiator, because it is not well adapted for the transfer of its energy to the surrounding ether, some thirty or forty oscillations taking place before there is any serious damping. Great precision of tuning is therefore necessary.

It will be instructive to compare this arrangement of Professor Lodge's with a standard Hertz oscillator and resonator, as shown in Fig. 2. A powerful induction

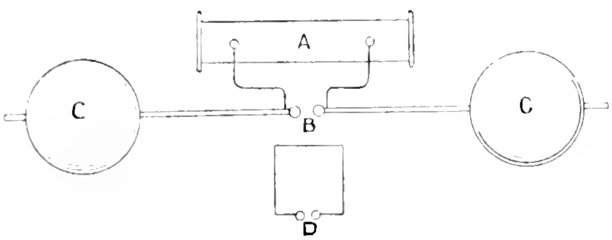


Fig. 2.—Hertz Oscillator and Resonator.

N.B.—C, C, are spheres with wires shown through centres, and therefore represented by circles. D is square of wire.

coil, A, having the terminals of its secondary circuit connected with the oscillator, which consists of a pair of brass rods terminating in small polished knobs, B, the distance between which is adjustable, while two large metal spheres, C, C, slide on the brass rods. By altering the positions of these spheres the oscillator can be tuned into syntony with the resonator, D, consisting of a wire rectangle or circle, terminating in a pair of polished brass knobs, which should be very close together.

If Lodge's exciting jar had its two coatings removed to a considerable distance apart, and the dielectric separating them were made to extend out into the room, we should obtain the equivalent of the Hertz oscillator, which is of the most suitable form to facilitate the transference of its electric wave energy to the surrounding ether. When the coatings are close together, as in Lodge's form, the magnetic energy largely predominates over the electrostatic. When the distance between them is increased and the dielectric more exposed, the electrostatic energy becomes more nearly equal to the magnetic, and therefore the arrangement gains in efficiency as a radiator, since in true radiation the two energies must

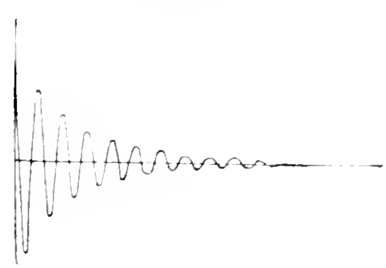


Fig. 3.—Oscillations of Dumb-bell Hertz Oscillator.

be nearly equal. The spheres, C, C, may, if desired, be replaced by large metal plates.

By means of calculations from the readings of an electrometer inserted in the air-gap, D, Fig. 2, Bjerknes succeeded in obtaining curves representing the damping of the oscillations. Figure 3 shows the oscillations obtained with a dumb-bell oscillator, such as that illustrated in Fig. 2, and it will be observed that they die away with extreme rapidity.

The persistent character of the oscillations excited in a ring resonator by an oscillator tuned to syntonism with it is shown in Fig. 4.

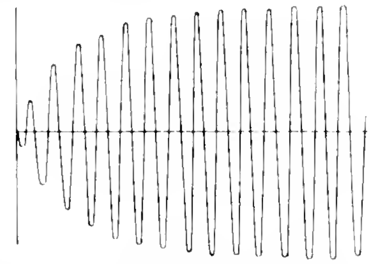


Fig. 4.—Oscillation of Ring-shaped Hertz Resonator excited by Syntonic Oscillation.

Just as in the case of acoustic resonance, when the resonator has its natural oscillations strongly damped, the tuning of the oscillator into syntony with it is of comparatively small importance, but if its oscillations are persistent then exact tuning is essential. Exact syntony is also necessary whenever the exciter is a persistent oscillator, as otherwise it will tend to destroy at one moment the oscillations which it set up a moment before. This is well shown in Fig. 5, which exhibits

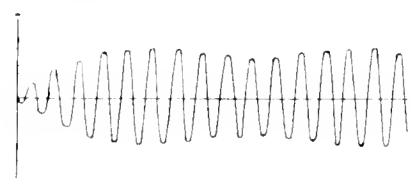


Fig. 5.—Oscillation of Ring-shaped Hertz Resonator excited by Oscillation not quite Syntonic with it.

the oscillation of a ring resonator, excited by an oscillation not quite in syntony with it.

To understand how an electrical oscillation, or its equivalent, an oscillating charged body, can excite electric waves in the ether, I will ask my readers to refer to Fig. 6 in my last article. Let the rack represent the electrically charged body, and imagine it is oscillating backwards and forwards in the direction of its length. This will set up a rotary oscillation in the wheelwork, and the wheelwork being, as has been assumed throughout, elastic, this rotary oscillation will be propagated with a velocity depending on the elasticity and the density, as has already been explained. The axes of the wheels represent the direction of the magnetic rotary oscillation, and this is perpendicular to the line of rack which represents the direction of the electrical oscillation. The direction in which the wave is advancing is perpendicular to both of them. Hertz by exploring with his resonator the space in the neighbourhood of an oscillator succeeded, not only in demonstrating the existence of electric waves, but in differentiating between the electrostatic and magnetic oscillations. He also succeeded in proving they had all the well-known properties of light and heat waves.

The Discovery and Development of the Coherer.

Hertz's splendid results were all obtained with only the simple resonator shown in Fig. 2 as a detector of the presence of electric waves. This would, however, not have been nearly sensitive enough for transmitting signals over considerable distances, even with the most perfect oscillators or transmitting instruments, and each transmission, therefore, only advanced into the realm of the possible with the discovery of the microphonic transmitter, or, as Professor Lodge calls it, the *coherer*, which was not brought into general use for this purpose until years later, although it had been discovered and actually used for the detection of the presence of the Hertzian waves by that great and patient experimentalist, Professor Hughes (whose loss we have so recently had to lament), as far back as 1880, some half-dozen years before Hertz began his investigations.

His experiments were shown to Sir George Gabriel Stokes and other physicists in 1879 and 1880, but owing to their unfortunate failure to grasp the meaning of them as Hughes himself certainly did, their publication was deferred. The result was that Hughes found his own discoveries as to the sensitiveness of the microphonic contact, and its useful employment as a receiver for electrical ether waves, remade by others.

A capital historical sketch of the course of this discovery was given by Professor Lodge in the *Electrician* for November 12th, 1897, from which much of what follows has been taken. In this article he suggests that probably the earliest discovery of cohesion under electric influence was contained in a forgotten observation of Guitard in 1850, that when dusty air was electrified from a point the dust particles tended to cohere into strings or flakes, and points out that the same thing occurs in the formation of snowflakes under the influence of atmospheric electrification, and in the cohesion of small drops into large ones in the neighbourhood of a charged cloud forming the familiar thunder shower. In 1879, Lord Rayleigh showed that when a stick of rubbed sealing wax was brought within a few yards of a small fountain which was scattering its spray in all directions, the scattering ceased, the broken jet rising and falling in large heavy drops.

The next stage, with the exception of Professor Hughes's work, which it must be borne in mind remained unknown during the whole of the development described in what follows, was the re-discovery by Professor Lodge and the late J. W. Clark of Guitard's dust phenomenon when experimenting on the cause of the dust-free region of air discovered by Professor Tyndall as existing over hot bodies, and erroneously ascribed by him to the dust being burnt up, but which was shown by Lodge, Osborne, Reynolds and others to be really due to molecular bombardment, phenomena analogous to those occurring within a Crookes' radiometer.

Before, however, arriving at this explanation, experiments were made to see if it was caused electrically, and it was found that when the hot body was placed in a thick smoky atmosphere and then charged with electricity the smoky atmosphere immediately became clear. In 1889, Professor Lodge was investigating the action of the lightning guards used for protecting telegraphic instruments from the effect of the sudden rushes due to lightning discharges. These were made by adding as a shunt to the circuit containing the instrument, an open circuit with a small air-gap, with terminals consisting of a pair of small brass balls, across which the discharge jumped, rather than flow round the coils of the instrument, which had great self-induction, and therefore offered much opposition to a sudden rush of current. Lodge found that when the knobs were placed too close together even a Leyden jar discharge would often short circuit the gap, the knobs being found both by electrical and mechanical tests to be feebly united at a single point. When the knobs were in mechanical contact, and separated only by an extremely thin film, consisting probably of oxide, extremely feeble sparks were found to be sufficient to produce this effect. The adhesion of the two surfaces were demonstrated by means of an electric bell placed, together with a single battery cell, in the circuit, and every time a spark occurred the bell rang, and continued to ring until the table on which the apparatus was standing, or some part of the support of the knobs, was tapped, so as to shake them asunder again. The arrangement was found to form a convenient detector in the syntonic Leyden jar experiment described at the beginning of this article.

If the electric bell was placed on the same table as the sparking knobs, or, better, were allowed to touch them, its tremor was found to be quite sufficient to effect this separation, unless the spark and, therefore, the adhesion had been too strong. In the meantime, Hertz's experiments had attracted general attention from physicists. Professor Minchin, in 1891, when working with some photo-electric cells, and especially some which behaved abnormally, as it seemed to him at the time, and which he called "impulsion cells," found that when a Hertz oscillator was working in another part of the r om the electrometer connected with his cells responded, and by means of this detector, which certainly depended on the coherer principle, he succeeded in signalling without wires over a considerable number of yards.

Professor Boltzmann, about the same time, used a charged gold-leaf electroscope for a like purpose, arranging it so that the electroscope was just on the point of discharging across a minute air-gap, so that its leaves were deflected by a definite amount. It was found when in this condition to be extremely sensitive to Hertz waves, which, if excited in any part of the room, would bridge over the gap and discharge the instrument.

This, as Professor Lodge points out, is not a detector depending on the principle of cohesion, but it led him, when repeating the experiment in a modified form, to the conclusion that cohesion could be effected by the surgings due to the regular Hertz waves.

One of the modifications adopted by him was to make the gap of carbon, and to connect it, with its wave collector, to the terminals of the 110-volt electric light leads, so that whenever a Hertz oscillator was discharged across the gap, the spark would close the circuit and set up an arc. This method was suggested to him by the observation of the behaviour of some incandescent lamps used to light his lecture tables, which were shaded on one side, and prevented from rotating, by means of a pair of copper wires stretched across the lecture room. As long as the wires were there the lamp fuzes used to blow whenever a Hertz oscillator was worked in the room, owing to these wires acting as collectors, and they were therefore replaced by silk threads, when the fuzes ceased to blow.

In 1891, Professor Branly, of the Catholic Institute in Paris, published some experimental researches of the greatest importance, in which he showed that metals in the state of powder or filings, and also various mixtures of metallic powders with non-conducting ones, which ordinarily offer an extremely high resistance to the passage of an electric current, fell enormously and quite suddenly in resistance whenever an electric spark occurred in the neighbourhood. This lowered resistance continued for some time, but the powder could be instantly restored to its high resistance state by tapping it, and in some cases by increasing the temperature. Branly found that when the powders had once been submitted to powerful electric action mechanical shocks did not restore them entirely to their original state, but that they continued to show themselves very much more sensitive to electrical actions. Some few bodies, such as peroxide of lead, had their resistance increased by the action of the electric sparks, and others again had their resistance alternately increased and diminished. The last results are curious and interesting, but the important case for its application to Hertzian telegraphy is that of diminished resistance. Branly's results became known to Professor Lodge at the end of 1893, when he at once proceeded to try the Branly tubes of filings, and found them greatly superior in manageability to either the Boltzmann gap or his own delicately adjusted cohering knobs, but immediately afterwards he, in conjunction with Professor Fitzgerald, devised a coherer consisting of a sewing needle resting upon aluminium foil, which they found to be of extraordinary sensitiveness and at the same time reasonably manageable. Professor Lodge then made a whole series of what he describes as quasi-optical experiments with the new detector, and, before long, various improved methods of arranging the filings were discovered, especially that of sealing them up *in vacuo* or in hydrogen, in order to protect them from oxidation by the air, the effect of which would be to produce too great a thickening of the extremely thin film separating them from one another. When brass filings immersed in hydrogen were used, they soon became too clean, and their sensitiveness so great that it was impossible to restore the original high resistance by tapping. Professor Lodge consequently preferred the vacuum obtained by the use of a Sprengel mercury pump. He states that almost any filings tube was capable of detecting signals sent from a distance of 60 yards, with a mere six-inch sphere used as oscillator, and without the slightest trouble, but that he found the single point coherer much more sensitive than any filings tube.

For tapping back, the use of an electric bell mounted on the base of a filings tube was not found very satisfactory, owing to the disturbances produced by the small sparks occurring at its contact breaker, to which this more delicate detector responded as well as to the signals which it was meant to attend to, while the less delicate knob apparatus had not been so affected. A tapper consisting of a rotating spoke wheel driven by the clockwork of a Morse instrument and giving the coherer a series of jerks at regular intervals was therefore employed.

Mr. Rolls Appleyard and Lord Rayleigh have devised a liquid coherer consisting of two globules of mercury separated by a thin film of grease, such as paraffine oil. When a battery cell is connected up in a circuit with these globules, they are pressed together every time the circuit is closed, and Lord Rayleigh has observed that it takes an appreciable time before they come into contact, as though a film had to be mechanically squeezed out from between the oppositely charged metallic surfaces, and this suggests that cohesion may in every case be simply a result of electrostatic attraction, and that the molecular films separating solids in contact may be squeezed out in a similar manner. The force of attraction between two surfaces differing in potential by a volt and separated by the smallest known thickness of thin film (which is about 10.7 centimetres) would be equivalent to about 650 pounds to the square inch, a quite sufficient pressure to make this explanation a perfectly possible one.

PLANTS AND THEIR FOOD. V.

By H. H. W. Pearson, M.A.

We have now to consider the means by which the food constituents of the soil enter the plant and are carried upwards to the leaves; for it is in the cells of the leaves that the food supplies from the atmosphere and from the soil are brought together and undergo chemical changes. This important work of the absorption of mineral food from the soil is entrusted to the root, which in most cases serves the additional purpose of holding the plant firmly in position, and frequently also acts as a storehouse in which is laid by food or water for future use.

If a bean or pea be soaked in water until the embryo swells and bursts the seed-coat, it is seen to consist of two comparatively large and thick embryo-leaves or cotyledons, a minute bud or "plumule" between them, and, in a straight line with this, projecting beyond the cotyledons, a very small papilla, which is the embryonic root or "radicle." The cotyledons contain so much organic food material—starch and proteid—that the embryo in the early stages of its growth needs no root, but grows at the expense of these materials stored up for its use by the mother-plant. Meanwhile the tiny radicle insinuates itself between the soil-particles and grows downwards, and later gives off minor branches, and so becomes capable of laying the soil under contribution to supply the mineral needs of the commonwealth of which it forms a part, as soon as the stores in the cotyledons are exhausted. In many plants—*e.g.*, the Grasses—the radicle perishes almost as soon as it emerges from the "seed," and is replaced by numerous branches arising from the scar left by the defunct radicle or from the lower part of the stem or leaves.

The fact that roots grow downwards is so well known that mention of it may seem superfluous. This habit is due to the influence of gravity. It is easily noticed that the main root (produced by the continued growth of the radicle) is more strongly influenced by the force of gravity than are its side-branches, for while it strikes a course which is, in the main, towards the earth's centre, its branches make a considerable angle with it, and frequently grow in a horizontal direction. Consequently the roots are able to exploit a much larger area of soil than would be possible if the branches and the main root were equally amenable to gravity. A further peculiarity in the growth of most roots is that they shun the light and take the shortest course to dark or shady places. On an ivy stem the clinging roots by which it is attached to the wall or tree all emerge on the shady side of the stem and proceed at once to bury their sensitive tips in the nearest hollows of the support. There are, on the other hand, roots which behave like stems, in that they bid defiance to gravity and grow erect and show no tendency to hide themselves from the light. These, however, are quite exceptional, and as a rule serve the plants which produce them in other ways than by the absorption of food. These two characters possessed by most roots—viz., a tendency to grow (1) in the direction of gravity and (2) away from the light—cause them to penetrate the soil in which their quest (mineral food) is to be found.

The soil varies considerably in composition, and even within small areas the distribution of moisture—and therefore of available plant-food—is by no means uniform. Roots have a third character, which enables them to follow such a course in the soil that they tap the places most richly supplied with moisture and nutriment. The root-tip is extremely sensitive to moisture, and will travel through the moister parts of the soil even if by so doing it leaves the more direct downward course dictated by gravity. This fact is of immense importance to the root in its search for food, for it is guided, as by an unerring instinct, to just those places where food in an available form is to be found. It is not difficult to see for oneself evidence of this interesting behaviour of the root in the presence of moisture. A sieve is made by fastening some netting to a box from which the bottom has been removed; it should be about two inches deep and eight inches from side to side. The sieve is filled with moist sawdust in which some barley grains are sown, and then hung up in a greenhouse* in such a way that the netted surface makes an angle of 45° to 50° with the vertical. As the roots grow through the bottom of the sieve the attraction exercised by the moisture in the sawdust overcomes the effects of gravity and they are deflected from the vertical and grow downwards along the inclined surface of the sieve.

The younger parts of the root are provided with so-called "root-hairs," the organs actually concerned in bringing into the plant the mineral solution of the soil. Each hair is produced by the elongation of a single cell of the root surface.† They appear on the young part of each branch of the root a little distance behind the apex, and fall off as it becomes older and thicker. Only those parts of the root which are provided with "hairs" are able to take in solutions from without. They are usually thickly placed on that part of the root where they occur, and very short—as a rule, much less than ⅛ of an inch long, but sometimes ¼ inch or more. Their formation is much influenced by the conditions under which the root grows, for they are more abundantly developed in a moderately dry than in a very wet soil. On the other hand, if the soil be very dry, or so compact and hard as to offer much resistance to the growth of the root, their formation is hindered. The connection between the root-hairs and the soil particles is very intimate; this is seen on uprooting almost any young plant, when it will be found very difficult to remove the last traces of soil from the younger parts of the root. The root-hair, choosing in its growth the path of least resistance, comes into close contact with particles of soil at various points; at the places of contact its cellulose wall becomes soft and jelly-like, so that the particle is more or less embedded in it.‡

The root-hair is merely a long cell, and, like other living cells,§ is surrounded by a cellulose wall, on the inside of which is a lining of semi-fluid protoplasm. As much of the cell as is not occupied by protoplasm is filled by the cell-sap, a solution of organic and inorganic substances. Outside, the root-hairs are bathed by a weak solution of mineral salts, the water of the soil. There are thus two solutions separated from one another by a double wall, the outer of cellulose and the inner of protoplasm.

The cellulose wall being very minutely perforated,‖ the two solutions are provided with passages by which they can communicate. Under these circumstances physical forces are called into play, and the fluid particles in the minute passages in the cell-wall are set in motion. Owing to the presence in the cell-sap of various organic substances in the plant-cell, the solution in the soil passes into the cell, which becomes in time full and the elastic cellulose wall distended—a condition in which the cell is called "turgid." The pressure within the cell, which may be as much as four or five atmospheres, is then only relieved by the transference of some of the cell-sap onwards to other cells. The root-hair thus obtains the nutrient solution which it seeks by the purely physical process of osmosis, and passes it on to the interior cells.

If the wall separating the cell-sap and the soil solution consisted of the cell-wall only, without the lining of protoplasm, the passage of solution into the cell would take place in the same manner, but certain modifications are caused by the presence of the inner wall of living protoplasm. If a slice of fresh beet-root be carefully washed and placed in clean cold water no red colouring matter escapes, but the water remains clear and colourless. On heating, a change occurs; when the water is boiled it is coloured red by the sap which escapes from the cells of the beet-root. As long as the protoplasm lining the cell-wall is living it prevents the coloured sap—and other substances as well—from escaping, but as soon as it is killed, by raising the temperature or in other ways, it loses this power and the sap diffuses through it into the water. The living protoplasm thus exercises some control over the dissolved substances which leave and enter the cell; and, further, a solution which enters at one time is unable to escape at another. It is probable that the constitution of the protoplasm varies from time to time, though in what precise manner and under the influence of what cause or causes it does not at present admit of explanation. The fact remains that the protoplasm as long as it is alive prevents some substances from entering the cell and others from leaving it. Despite this control, a large quantity of mineral matter enters the plant which is of no use to it as food and may indeed be harmful. We have noticed in the case of Silica¶ an instance of the absorption of large quantities of a substance which is of no food-value to the plant.

The roots of many plants not only absorb mineral food from the soil but are also manufactories in which the transformation of free Nitrogen into an oxidised state occurs. It has long been known that agricultural land is improved by ploughing into it the remains of previous crops, and that the benefit derived is greater in some cases than in others. Nearly 300 years ago Bacon wrote**:—"The Fourth Helpe of Ground is the

* Or in a dark room: in this case the floor of the room should be occasionally watered, that the air may not become so dry as to cause the withering of the roots.

† *See* figure in Knowledge, July, 1900, p. 160, *h*, *h'*.

‡ *See* figure in Knowledge, July, 1900, p. 160, *s*, *h*.

§ Knowledge, January, 1900, p. 3.

‖ Knowledge, January, 1900, p. 3.

¶ Knowledge, May, 1900, p. 101.

** "Sylva Sylvarum," p. 146.

Suffering of Vegetables to die into the Ground: And so to Fatten it: As the Stubble of Corne, Especially Pease." Equally beneficial with "Pease" are other crops, such as clover, belonging to the Natural order Leguminosæ (so-called because its members produce a fruit known as the "legume" or "pod"). The roots

A Lupine Plant, reduced from a drawing by Miss E. E. Pratt, showing the tubercles (*t*) on the roots.

of many plants belonging to this order are swollen or knotted at intervals like that of the garden Lupine shown in the figure. Similar tubercles are sometimes found also on the roots of the Alder and a few other less familiar trees and shrubs. Needless to say, they were observed long before their importance to the plant was realised. On examining a section cut through one of them, it is seen that the tissues of the root have been stimulated to increased growth, causing the part affected to swell. Such an abnormal growth of an organ is often caused by the presence within it of a foreign organism. And so it is in this case, for in the cells of the tubercle is a multitude of minute residential organisms to which we hesitate to apply a name. In some stages of their existence they resemble bacteria, by which name they are frequently called. Their exact nature is, however, still under discussion; it is certain that they are not true bacteria, but probably the degraded descendants of ancestors belonging to one of the lower groups of the Fungi. The work done by these tubercle organisms has been studied only in a few members of the Leguminosæ, but it is probable that wherever they are found they are equally important to the plant in whose roots they live. On some roots the tubercles are found in large numbers; more than 4,500 have been counted on a single pea-plant.

In a previous article†† it has been noticed that most green plants obtain their Nitrogen in the form of Nitrates (*i.e.*, oxidised Nitrogen), and that they are unable to make use of the free Nitrogen of the atmosphere. When certain leguminous plants, such as the Lupine, are grown in soil which contains no Nitrates, they may die from Nitrogen starvation, or, on the other hand, they are more likely to grow in normal luxuriance. If the plants which die under these circumstances are examined their roots are found to be quite free from tubercles; while the roots of those which flourish are invariably provided with tubercles, in the cells of which is the usual population of organisms. If the soil is strongly heated and then allowed to cool before the Lupine is planted in it, and afterwards carefully protected so that no impurities from outside may reach it, the roots grown in it do not become swollen, *i.e.*, they are not invaded by the organism which causes the swellings. The organism is present in the soil, and under ordinary circumstances "infects" certain roots, such as those of the Lupine; but if the soil has been previously heated, bacteria and other living inhabitants are killed, and roots grown in it afterwards do not become infected. What the Lupine and similar plants require in the soil is not an abundant supply of Nitrates but the presence of the minute organism which infects and establishes colonies in its roots.

The facts of the last paragraph clearly indicate that the work of the root-organism consists in the production of compounds of Nitrogen which can be made use of by the plant which gives it lodging and partial "board." As a result of much careful and reliable investigation we now know that the free Nitrogen of the atmosphere‡‡ is oxidised by the activity of these humble guests, and the resulting Nitrates are passed on to the host-plant. The latter not only houses its guests during their lifetime but apparently also consumes their remains after death, thereby doubtless making use of the stores of accumulated nitrogenous compounds in their bodies. This is one of the most promising fields of future investigation, and many interesting results may yet be expected from it. For the present, we must realise that we know very little about the details of the co-operation between the flowering plant and the soil-organism—a union which was not suspected two or three decades ago. We are at least certain that some leguminous plants are rendered independent of supplies of Nitrates in the soil by reason of the activity of minute soil-organisms which reside in their roots, assimilate free atmospheric Nitrogen and pass it on to their host in an oxidised state. At the end of the growing season the root of such a plant contains a store of nitrogenous substances ready to be absorbed by plants whose existence depends upon a supply of oxidised Nitrogen. The roots of a crop of leguminous plants such as "Pease," left to decay in

†† July, 1900.

‡‡ All soils contain air, and therefore free Nitrogen. *See* figure in Knowledge, July, 1900, p. 160.

the soil, enrich it by adding to it such compounds of Nitrogen, and thereby render it more fertile the next season for a crop which possesses no means of utilising the free Nitrogen of the air.

NOTES ON COMETS AND METEORS.

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

Borrelly-Brooks's Comet.—This object has formed a very interesting one for telescopic observers during the last two months. It has exhibited a well defined tail and bright head; in fact its aspect has been that of a large comet presented in miniature. Its motion away from the earth and sun has now rendered it extremely faint, and it will soon pass beyond the range of the most powerful telescopes. At the beginning of October the position of the comet is 5 degrees S.W. of the stars $\beta - \gamma$ Ursae Minoris, and its motion is directed towards the S.E., but it is now apparently travelling very slowly. A very large number of observations of this object have been obtained at observatories in various parts of the world. Its orbit appears to be parabolic, but definite elements have not yet been computed.

Barnard's Comet (1884 II.).—In Ast. Nach. 3660, A. Berberich gives a sweeping ephemeris of this object. Its perihelion passage will probably take place at the end of October, but the precise date is uncertain. On October 23 the computed place of the comet will be R.A. 17h. 31m., Dec. − 27° 12′, but its southerly position and great distance (nearly 150 millions of miles) from the earth must prevent its being seen in this country except in a very powerful telescope. The comet was discovered in 1884, and has a period of about 5½ years. It must have returned to perihelion in 1890 and 1895, but escaped observation on both occasions. It seems probable that, in view of the unfavourable conditions, the comet will again elude detection during its present return.

Fireballs.—A considerable number of these objects have been reported from various places during the past two months. In the majority of cases, however, the observations are not sufficiently full and accurate to enable the real paths of the meteors to be computed. On July 30, at 10h. 46m., a very brilliant Perseid was seen from the S.W. part of England and from Jersey. It fell from a height of about 95 to 50 miles over the English Channel, S. of Cornwall. On August 12 several brilliant fireballs appeared in the moonlight. Two are described by the Rev. T. E. R. Phillips of Yeovil. One of these was seen at 10h. 21m., and was brighter than Venus. It travelled from 291½° + 30° to 271° − 7°, and was a fine Perseid. The other came two minutes later, and shot from 252° + 24° to 195° + 59°, and was probably directed from the same radiant as the fireball of July 24 at 280° − 15°. On August 19, 10h. 36m., the end point of a brilliant fireball was observed by the writer at Bristol at 198° + 26°, and the same object was seen at Yeovil by the Rev. T. E. R. Phillips, and at places in Ireland by other observers. Its radiant point was at 316° + 1°, and it descended from 56 to 29 miles over the east coast of Ireland, but only the latter portion of the flight seems to have been satisfactorily recorded. When the fireball first became visibly incandescent it was probably much higher than 56 miles, and it is hoped that further observations of it will come to hand. On August 22, 10h. 8m., a fine meteor estimated equal to Jupiter was seen by Mr. A. King at Leicester, and by the writer at Bristol. It proves to have been a Cygnid from a radiant at 310° + 53°, and having heights of 75 to 50 miles.

Large Daylight Meteor of September 2.—Just before sunset on September 2 at 6h. 54m. a magnificent meteor was seen from the northern counties of England and from Scotland. A considerable number of descriptions have appeared in the newspapers, and Mr. W. H. S. Monck, of Dublin, has collected and kindly furnished me with many of these. The meteor appeared at a time when there were no stars or planets visible by which to mark its apparent path, hence the accounts give positions which were only roughly estimated. A full discussion of the materials has not yet been attempted, but it appears certain that the meteor disappeared over Lancashire at a height between 20 and 25 miles, and that it was directed from a radiant probably in Cepheus at 331° + 57°. At Bristol 5 meteors were observed from the shower later on the same night but they were small. The faintest meteors and the largest fireballs are, however, directed from the same radiant points.

August Shooting Stars.—The full moon of August 10 practically obliterated the Perseids at and near the time of maximum display this year, but a few of the usual streak leaving meteors of this prominent system were noticed at various places. They appear to have been most numerous on the very clear night of August 12. The change in the position of the radiant was noticed by several observers. At Bristol, between August 16 and 26, in watches extending in the aggregate over 15 hours, 125 meteors were observed. The chief shower was at 316° + 1° (12 meteors), and there was another active radiant at 333° + 28° (11 meteors). The Perseids still exhibited striking activity on August 16, and indicated a radiant at 51° + 58°. On August 22 about 5 streak-leaving meteors gave a good centre at 59° + 59°, which is close to the computed place of the Perseid radiant, but there is a shower of Camelopardids from this point, and it is possible that the meteors were not real Perseids. The observations are, however, very significant that the Perseid shower continues until August 22. This was distinctly suggested by Lieut.-Col. Tupman's observations in the Mediterranean in 1870, but I recognised very little if any evidences of the prolongation of the shower on August 22 in the years 1879, 1884, and 1887, when I registered a considerable number of meteors on this date. The point is an interesting one. It will be important to learn in future years the visible strength of the shower on the nights intervening between August 16 and 22. The radiant is very well defined on the former date, but before assuming that it continues in action to the 22nd we must thoroughly watch for it on the immediately previous nights, and this will enable us to assign definite limits to the showers' sustenance. From the writer's own observations at Bristol there can be no doubt that Perseids continue to fall as late as August 19, but the Perseid-like meteors seen on following nights may belong to a distinct shower in Camelopardus, very well defined earlier in the month, and notably on August 16 at the point 61° + 60°.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

Mr. G. H. J. Rogers, F.R.M.S., has invented an improved form of compressor for which the principal advantage claimed is the ready replacement of the cover glass in the event of it being broken by accident.

Chinese cement is composed of finely powdered calcined lime 54 parts, alum 6 parts, fresh blood 40 parts. These are worked into a homogeneous mass. Pasteboard saturated with it will become as hard as wood.

One of the difficulties experienced by those who keep fresh water aquaria for the purpose of cultivating material for microscopical study or class work is the rapid decay of the plants, due in a measure to the ravages of the bacterial zooglœa that form on the surface of the water. To prevent this, the water must be supplied with oxygen by growing in it some good aerating plants like Myriophyllum, Cabomba, Ranunculus, water mosses, etc. Algæ like Vaucheria, Spirogyra, Chara, Nitella, Coleochaeta, Oedogonium, will thrive and fruit provided that the conditions are suitable. Where the aerating plants themselves do not thrive algæ may be successfully cultivated, provided that means be adopted to protect the surface of the water so as to exclude dust, but permit free access of air. If the aquaria are small, this may be readily effected by covering them with loose glass covers; but, where they are large, a better method is to encourage the growth of the floating plant Salvinia nutans, which propagates rapidly and protects the surface from the accumulation of bacterial zooglœa. Plants such as Azolla or Lemna would perform the same functions, but both of these have their periods of decay when they disappear altogether, while the Salvinia is in evidence all the year round.

A supply of fruiting Vaucheria may be obtained at any time of the year by carefully removing the mats from pots in greenhouses, and throwing them into a jar half full of water. The jar should be placed in strong sunlight, and in five or six weeks the material may show both methods of reproduction and will be practically free from dirt and other algæ.

Fresh water rhizopods are more common in the ordinary collections of the microscopists than is generally supposed, but since they are seldom looked for they are often passed by unnoticed. In systematic collections the superficial ooze at the bottom of still water should be examined, after it has been allowed to settle for some time in a suitable vessel. Rhizopods are common in the slime of submerged rocks, stems, and leaves, especially so in moist Sphagnum; they are to be found almost everywhere in moist situations not too much shaded, among decaying logs, mosses, lichens, and on the bark of trees.

The motion of camphor in water is well known. A German chemist, K. Schaum, has taken such readily soluble substances as potassium cyanide, potassium nitrate, silver nitrate, calcium chloride, and sugar, and has studied their travels in dissolving with the aid of the microscope by dropping single crystals upon mercury covered by water or dilute acid. The movements—greater in dilute acid than water—are very characteristic. The crystal first takes a zigzag course, then changes to a circular path, and finally turns rapidly on its axis. The rate of motion varies with the rate of solution and the surface tension of the mercury.

Particles of sand and gravel in the alimentary canal of earth worms that are being prepared for sectioning, and that may injure the edge of the microtome knife, can be removed by feeding the worms on bits of filter paper before killing them.

Microscopists will be interested to know that certain kinds of glass appear to be so soluble in water that moisture quickly etches the surface and destroys the transparency. Mr. E. F. Mondy, of Decca College, East Bengal, reports having noticed the dull matt appearance of a cut wineglass and of finger bowls in which water had been allowed to stand; also the spotting of two decanters which had been dried after partial draining. These effects were all due to water etching. This explains the rapid deterioration of optical apparatus in the moist climate of India. Proof that the fault is in the kind of glass used is furnished by the object glass of a 3½ inch telescope, the inner surface of the convex lens being badly corroded whilst the adjacent face of the concave lens was quite clear.

To avoid many of the failures that fall to the lot of the photo micrographer, the details of each experiment that is made should be systematically recorded so that the operator may have a guide on other occasions when the conditions are similar. For this purpose a book should be kept containing spacings for details regarding the objective, light, distance of light from object and plate, colour of object, plates, screens and time of exposure.

Great care and cleanliness are necessary in all microscopical work, but particularly in the study of powdered substances. Dust and all other foreign matter must be carefully removed from slides and covers. Great caution must be observed so as not to get different powders mixed. The same slide should never be used for different powders unless special care has been observed in cleaning them. If several slides are being prepared for examination be sure to label them, otherwise confusion is sure to follow.

Of all the media employed for the mounting and preservation of objects Canada balsam is the most generally useful, and it is probable that more objects are mounted in this material than in all others put together. It is perfect as a preservative, and its action in rendering many objects transparent is often of great value. Much of the Canada balsam that is sold is made of cheap resins dissolved in impure turpentine, and this explains many of the difficulties and failures that fall to the lot of the microscopist. To be good Canada balsam should be of thick consistence, nearly colourless, and thoroughly transparent.

In mounting objects in balsam the great difficulty to be encountered is the presence of air bubbles. Judicious management, however, enables one to avoid them. In the first place all bubbles should be removed from the balsam on the slide. This is more easily done before immersing the object in the balsam than afterwards. Next see that the air is expelled from the object; and lastly, that no air enters with the cover. To do this the cover should be made hot, and then slowly lowered on the balsam from one side.

Dr. E. J. Spitta finds that, when taking photographs of living bacteria such as the clumping of the typhoid germs in Widal's method of diagnosis, it is best to take advantage of diffraction effects and to close the iris to what would otherwise be considered an undue amount. By this means a faint "standing out" effect is produced which enables the bacteria to show sufficiently for the purpose, provided the exposure be short enough to prevent choking effects, and yet long enough to give a sufficiently dense background. He finds that ten seconds is sufficient with a subdued light, and using a one-sixth apochromatic objective. A vertical apparatus must be used.

To mount the antennæ of flies, wasps, and bees, it is necessary to soak the objects in chlorate of potash, with a few drops of hydrochloric acid, until they are colourless, and then mount in Canada balsam and benzole. The points requiring attention are these: soaking just the right length of time in the potash, for if the object remains too long in the liquid it will be destroyed; and manipulating it when mounting so as not to destroy the characteristic features.

[All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of Knowledge.*]*

THE FACE OF THE SKY FOR OCTOBER.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 6.2 and sets at 5.38; on the 31st he rises at 6.53 and sets at 4.35.

The Moon.—The moon will enter first quarter on the 1st at 9.11 P.M.; will be full on the 8th at 1.18 P.M.; will enter last quarter on the 15th at 9.51 A.M.; will be new on the 23rd at 1.27 P.M.; and enter first quarter again on the 31st at 8.18 A.M. The following are among the principal occultations visible during the month:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Oct. 1	B.A.C. 6347	6.0	8.32 P.M.	82	58	9.41 P.M.	249	217	7 25
„ 2	B.A.C. 6710	6.0	10.8 P.M.	31	2	10.58 P.M.	290	256	8 26
„ 7	κ Piscium	5.0	1.35 A.M.	78	[illegible]	2.29 A.M.	[illegible]	236	13 6
„ 11	ω Tauri	4.6	8.17 P.M.	33	71	9.25 P.M.	265	316	17 25
„ 14	ι Geminorum	4.0	3.0 A.M.	10	68	3.43 A.M.	[illegible]	[illegible]	20 7
„ 29	δ Sagittarii	4.9	8.27 P.M.	158	127	8.46 P.M.	[illegible]	202	6 8

The Planets.—Mercury is an evening star throughout the month, at greatest eastern elongation of nearly 24° on the 30th, but is too far south to be easily observed in our latitudes.

Venus remains a morning star, rising on the 1st about 1.45 A.M., and on the 31st about 2.50 A.M. The planet is in Leo until the 28th, and will be less than a degree south of Regulus on the 7th. At the middle of the month the diameter of the planet will be 18″.4, a little more than six-tenths of the disc being then illuminated.

Mars rises a little before midnight throughout the month, and is gradually becoming more favourably placed for observation. The planet has an easterly motion, passing from Cancer into Leo about the 25th. On the 15th, the apparent diameter of the planet is 5″.8, and the illuminated part 0.902; the distance of the planet from the earth at this time is nearly 149 millions of miles.

Jupiter is still an evening star, in Scorpio, but too close to the sun for observation, except under very favourable circumstances. At the beginning of the month the planet sets before eight o'clock, and at the end of the month soon after six.

Saturn remains an evening star, in Sagittarius, setting soon after 9 P.M. on the 1st, and about half-past seven on the 31st.

Uranus is an evening star, but so near the sun, and so low, that it may be considered not observable.

Neptune rises soon after 9 P.M. on the 1st, and soon after 7 P.M. on the 31st. He is stationary on the 2nd, and afterwards describes a short westerly path in Taurus, almost midway between 132 Tauri and Eta Geminorum.

The Stars.—About 9 P.M. at the middle of the month, Auriga and Perseus will be in the north-east; Taurus low down in the east; Aries, Pisces, and Cetus in the south-east; Andromeda and Cassiopeia high up and a little south of east; Pegasus and Aquarius in the south; Cygnus high up to the south-west; Aquila a little lower in the south-west; Lyra and Hercules towards the west; Corona towards the north-west; and Ursa Major in the north.

Minima of Algol will occur on the 9th at 10.40 P.M., and on the 12th at 7.29 P.M.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of September Problems.

No. 1.

(N. M. Gibbins.)

1. Kt to Kt3, and mates next move.

No. 2.
(C. D. Locock.)
1. P to Kt5, and mates next move.

CORRECT SOLUTIONS of both problems received from Alpha, H. S. Brandreth, G. A. Forde (Capt.), W. de P. Crousaz, G. W. Middleton, C. F. Pilcher, K. W.

Of No. 2 only, from H. Le Jeune.

P. G. L. F. and W. GEARY.—Many thanks for the problems.

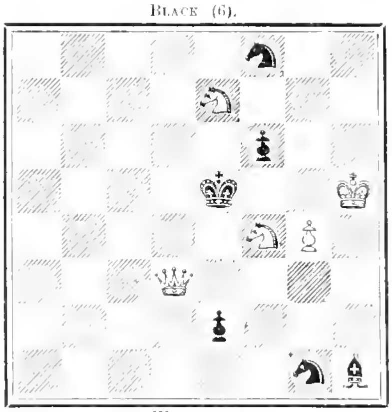
H. LE JEUNE.—If 1. Q to R3, B × Kt, and there is no mate.

P. VAL BLAGY.—There is no solution competition in progress, though I hope to be able to arrange one shortly. In the mean time I venture to reply that the reason why solvers send in their solutions lies in their desire to show that they take an interest in the problem department of this page. Your solutions are incorrect. In No. 1 the Knight cannot mate at Q6 on account of the Black Pawn standing at QB2. In No. 2, after 1. B to Kt2ch, Kt × B, the White Queen, being pinned, cannot mate at Q3. This pinning of the Queen, whenever the Black Knight next to it moves, being indeed the main point of the problem.

C. F. PILCHER.—You will see that both your first attempts have proved correct.

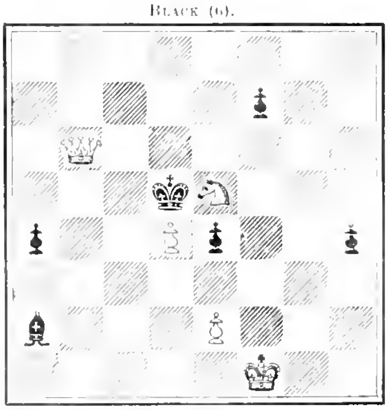
PROBLEMS.
By W. Geary.

No. 1.
BLACK (6).



WHITE (5).
White mates in two moves.

No. 2.
BLACK (6).



WHITE (5)
White mates in three moves.

CHESS INTELLIGENCE.

The Amateur Tournament of the Southern Counties' Chess Union, which carries with it the Newnes Challenge Cup and the Amateur Championship, began at Bath on September 3. There were 15 entries in the chief event, and Mr. H. E. Atkins again carried off the first prize without losing a game, scoring $12\frac{1}{2}$ out of a possible 14. Mr. Herbert Jacobs was a good second with $11\frac{1}{2}$, and Mr. Jones Bateman third with 10. The other competitors were Messrs. H. H. Cole, W. Ward, F. J. H. Elwell, B. D. Wilmot, A. Rumboll, E. B. Schwann, J. F. Allcock, P. R. Gibbs, J. E. Parry, A. L. Stevenson, C. J. Lambert, and F. Brown.

It is with great regret that we announce the death of Sheriff Spens, of Glasgow, for many years one of the leading players in Scotland, deservedly also one of the most popular. He was for many years chess editor of the *Glasgow Weekly Herald*, and the founder of the Scottish Association in 1884. He was distinguished also in literature as in chess.

The death of William Steinitz removes the most notable player of the past generation. He won the Chess Championship by his victory over Anderssen in 1866, and held it against all comers till his defeat at the hands of E. Lasker in 1894. During this long period he engaged in a very large number of matches, his most noteworthy opponents being Zukertort, Blackburne, Mackenzie, and Tchigorin. In all of these he was uniformly successful, generally by decisive majorities. In fact it was specially as a match player that Steinitz was supreme. A long series of games gave him time to recover from a bad start generally due to rash experiments in the openings. It was characteristic of the man that he would stick to these unsound ventures long after all experts had demonstrated their unsoundness. But for this he would have been an even more successful tournament player than he was, though in this branch of play he was certainly one of the best. The Steinitz Gambit cost him many games, as did strange defences to the Ruy Lopez, and attacks against the French Defence. This put him at a great disadvantage with all his fellow competitors. Every one knew what defence or attack Steinitz would play in any particular opening, and the weaker players were coached by the stronger to rob him of many a game. No one could be more brilliant than Steinitz when he chose (witness the often quoted game against Bardeleben at Hastings), but he preferred to win his games by the logical scientific method of which he was the inventor, christened by him "the accumulation of minute advantages." He did not care to slay his antagonist suddenly but preferred the method of slow strangulation. As a writer on the game he was painstaking and suggestive, if not always reliable, unrivalled too as an annotator of games. No player since Paul Morphy has had a greater or better influence on the game.

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STONE IMPLEMENTS ON THE GOLD COAST.

By LINDSAY W. BRISTOWE, *Gold Coast District Commissioner*, and H. P. FITZGERALD MARRIOTT, F.R.G.S.

COMPARATIVELY little is known of pre-historic stone implements from Western Africa. A fresh collection that we have recently gathered presents some interesting points, and induces us to give a general review of the subject, with the native legends concerning these objects. Winwood Reade, to whom the British Museum is indebted for a number of specimens, does not throw much light on them, but says at pages 2-4 in "The Story of the Ashantee Campaign":—"Not only are these stone implements dug up all over the world, but all over the world they are supposed by the common people to be thunder-bolts. As regards Western Africa, this belief is easily explained. The Stone Age is there comparatively recent, and many axes are merely covered by the upper soil. After heavy storms of rain, which are usually accompanied by thunder and lightning, this upper soil being washed away, the stone implements are found lying on the ground, and so seem to have fallen from the sky."

Sir Richard Burton mentions that he was told how Winwood Reade had found fine specimens of hatchets, with holes pierced for hafts, but that neither he nor Captain Cameron had found any on the Gulf of Guinea.

The stone implements that were found at Christiansborg, Akropong, and Aburi, are now in the Copenhagen Museum, which is unrivalled for its relics of the Stone Age. Some have also been found at Amoaful, and are in Sir John Lubbock's collection, whilst others, found at Akwapim, are in Sir John Evans's collection. The specimens deposited in the British Museum differ both in shape and material from those we have recently procured from Chama and Secondi, on the Gold Coast.

Before describing them, however, we will quote what has been incidentally written on the subject of their presence in West Africa. Winwood Reade says:—"The next time I saw a stone implement was in the tent of Mr. Kühne, at Prahsu. He had found it on an Ashanti altar, or shrine, as he was on his way from Coomassie (Kumassi) to the camp. I asked my interpreter if he had ever seen one before; he replied that they were 'found everywhere,' and I made a small collection during the march through Ashanti. When the troops took a village, I always hunted for this kind of plunder. Sometimes I found the stone hanging before doorways at the end of a string, like a plummet, and often it would be daubed over with chalk. The natives regard these stones with superstitious reverence, and call them god-axes; and believing that all things sacred are medicinal, grind from them a powder which they use for rheumatism and other complaints." We, however, rather doubt whether the stone implements are always daubed with chalk. It certainly is not the case nearer the sea-coast, though it may be in Ashanti, but more probably only on special occasions when the people themselves paint their own bodies white. It is probable that Winwood Reade saw these chalk-daubed stones only on his way down, when the natives were rejoicing at Wolseley's success, for it must be remembered that he was only a hurried passer through as correspondent to *The Times*.

Burton and Cameron describe all the specimens they came across as neolithic—that is to say, of the type produced by grinding. They found none that were palæolithic, or chipped. Arrow-heads and spear-heads are apparently unknown.

A native factotum for one of the local firms at Axim brought Sir Richard Burton some specimens, and told him that "the stones are picked up at the mouth of streams that have washed them down after heavy rains. But the people here, as elsewhere, call them 'Sráman-bo,' or thunder-stones. These Keraunia are supposed to fall with the 'bolt,' to sink into the earth and rise to the surface in the process of years. Hence the people search for them where the 'thunder has fallen.'" "The stones are used as medicine, and those of black colour have generally been boiled in oil to preserve their qualities. After this process they resemble the Basanos (Βάσανος) of Lydian Tmolus. On the Gold Coast, however, the touch-stone is mostly a dark jasper imported from Europe." "They are mostly of fine close felsite or the greenstone trap (diorite), found everywhere along the coast. I heard, however, that at

Abusi, beyond Anamabo, and other places further east, specimens of a lightish slaty hue are common. Captain Cameron, whose fine collection is described elsewhere, brought home one that felt and looked like a soapstone coloured *café-au-lait*."

He suggests that Axim was a great centre of stone manufacture, evidently because he observed a number of curiously marked boulders of green-stone, whinstone, ironstone, or diorite. He describes them as having their upper surfaces "scored and striped with leaf-shaped grooves, some of them three feet long by three inches wide and two deep." He thought it probable that chippings of the same rock were here ground to the required size and shape. Of course those geologists who know little of stone implements, Australian stone totems, etc., would naturally at once say on hearing of these grooves, that they had been caused in boulder drift. But we must remember that often the same result may be produced in two or more different ways, and that therefore Burton may be right.

In connection with this, it would be interesting to investigate the large boulder of granite, called Olumo, on the summit of a hill near Abeokuta in the Yoruba country, Lagos; for this boulder is sacred to Oro, and no one may ascend it. Oro means fierceness or tempest, it is also a society, probably manipulated by the Ogboni tribal society in the Yoruba districts. The word is specially applied to the spirit whose voice is heard, the voice being produced, as elsewhere in Africa, Australia, and America by the bull-roarer, or thin strip of wood, some two and a half inches broad, and a foot long, tapering at both ends, and fastened to a stick by a long string. But since in Australia a similar form has been found in stone as well as in wood, pierced by a hole at one end, and as the latter (of wood) are used as bull-roarers, the resemblance between Australian totems (*churinga* in the Central Australian dialect) and sacred stones in West Africa is striking, and may lead to some further discovery if carefully followed up near Abeokuta. Indeed, as the Olumo stone is sacred to Oro (the voice caused by the bull-roarer), it is possible that stones shaped like bull-roarers may be found to be amongst the secrets kept by the Oro Society, who certainly keep their wooden bull-roarers carefully out of sight of women and the profane. The Olumo may be the rock from which were cut stone bull-roarers, as well as working implements. An examination of its surface would help to decide the *pros* and *cons* of this suggestion.

In "Notes on Yoruba and the Colony and Protectorate of Lagos," a paper read before the Royal Geographical Society by Sir Alfred Moloney, K.C.M.G., there is the following:—"Nor is Yoruba excluded from the widespread belief that stone implements are thunder-bolts. Some rude celts, shaped as axes and chisels, I have collected; they are called ara* okó. The second great Orisá, or subject of worship, intermediate between man and god (olorun) is Sángó, the thunder-god, a name sometimes applied to the stone implements, which are believed to be the bolts of Sángó, who is also named Dzakuta, the stone-thrower. The greatest reverence is extended to these stones, which are used as family fetiches when they are found by ordinary persons."

"Dr John Evans has remarked upon the strong general resemblance between West African stone implements and those found in Greece and Asia Minor. In their practice, when engaged sacrificially, of daubing these stones with blood, palm oil, etc., the West Africans resemble the Indians."

The collection in the writers' possession, which contains twenty-four specimens, are all, with the exception of one, neolithic, and although diligent search was made, no chipped specimens could be procured; as Burton remarks, they are apparently unknown. Man, though very ancient in other tropical† or sub-tropical parts of Africa, in these districts of the West Coast probably appeared at a later period owing to the swampy vegetation, disagreeable climate, and presumable volcanic state of other portions. Moreover, here mankind does not seem to have developed a want for stone implements, whilst in other parts of the world he had long ago passed the palæolithic stage, for all those celts as yet found are highly finished, and there are none there that show a preparatory period of evolution. The perfection of these instruments goes far to prove that they were imported by migrating or conquering races, and that the ancient possessors of the low-lying forest coasts of West Africa, if they ever existed, had never even arrived at a Stone Age of any sort, being content to subsist on what could be obtained by wooden instruments, and on fruit and roots, torn by the hands from their place of growth.

The majority of the twenty-four specimens are of felspathic rock, some light in colour and others dark whilst real lidites and igneous rock are the materials from which the balance have been made. There is one formed from augitic lava, and another consists of a kind of augite and felspar. The exception already referred to is a touchstone, which has been in use among a family of native jewellers for the past century. It is of black limestone. As will be seen from the photographs of these celts, specimens Nos. 4, 14, 17, and 19, are particularly good in shape and size. No. 21, the darkest and smoothest of the light green (felspathic rock) axe-heads, is like in colour, and probably in material (but not in shape), to some in the Japanese section of stone implements in the British Museum, marked Hakodate. Those axe-heads or wedges in the British Museum, presented by Mr. Andrew Swanzy, and collected by Mr. Winwood Reade at Odumassie, near the Volta, and in the province of Akwapim, Gold Coast, are none as broad at the edge as those of the present collection, only a solitary small one approaching the same shape, but there appear to be none like No. I in either form or material.

The Gold Coast is rich in these interesting pre-historic remains. From one extreme of the colony to the other, specimens are to be found, and we venture to think the present collection a valuable addition to those already unearthed. We studied the subject, however, more from an ethnological standpoint than any other.

The similarity of ideas that prevails in the superstitious beliefs of the human race on the subject of neolithic celts is well worthy of study, not so much on account of the main idea that they are thunder-bolts, as for the almost identical beliefs obtaining as to the wonderful properties possessed by these stones. There is universal belief in their being sovereign protectors against lightning. The Norse peasants hung them in

* I rather suspect that this word is the same as *Oro*, for the annual festival of Oro at Ondo, in the Yoruba country, is called Oro Ileko, for even natives pronounce identical words very differently.—H. P. FG. M.

† "Appleton's Science Monthly" (London and New York), Nov., 1895, p. 25, etc., of "Primigenial Skeletons, the Flood and the Glacial Period," by H. P. FitzGerald Marriott.

vats to insure good brews; the West African in his drinking water to render it pure and cool; the Indian of Central America does the same thing. Fishermen and hunters, both in the Old and New Worlds, use them to bring good luck. There is the widespread belief that these stones possess extraordinary curative virtues for severe abdominal pains, either in fever or child-birth; for charms against snake-bites they are a specific.

So far, however, as the West African negro is concerned, an interesting question arises. Does he regard these stones as sacred objects, as objects of devotion, and have they a place in their complex religious beliefs?

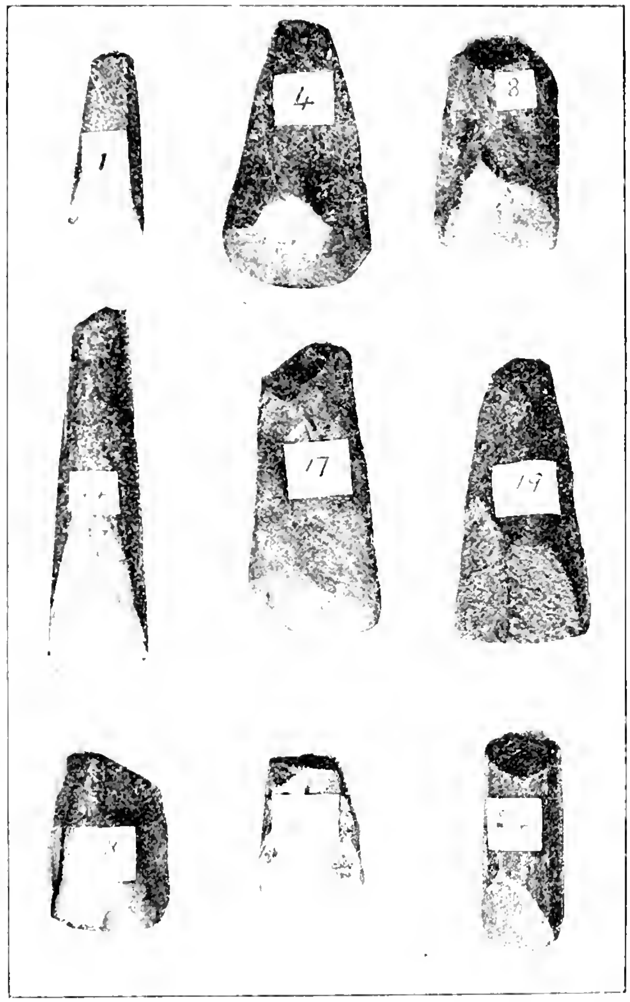
To attempt to understand the native mind, and obtain a grasp of their fundamental ideas of religion and morality, requires not only years of patient investigation, untainted by racial prejudice, but it involves a sympathetic interest in all his petty disputes and troubles—none the less real and important to him—and the utmost assistance is to be derived by the study of his folk-lore, as elucidating his mode of thought and the motives that actuate his conduct and actions. A depth of hidden meaning lies buried beneath their simple stories, which have been handed down to them from remote antiquity, in some cases, whilst others are of quite recent date, and tend to show that he is, in thought and ideas, still where he was centuries ago.

It is to the anthropologist that we must look to elucidate the conflicting opinions prevalent on this interesting branch of the human race. In his search after truth, he will gratefully accept the aid of the folklorist, who, gathering his knowledge from all sources, will discover that thunder-bolts lie scattered through his domain.

The West African, however, is by nature suspicious. He is perpetually haunted by the idea that some deep motive underlies your questions, and until he gets to know and trust you, takes a particular delight in leading you astray. Even Cruikshank, who lived among them for fifteen years, and was much respected, found the subjects of their religious beliefs "beset with difficulties." As a contribution to this study, we have searched the Coast for these implements and carefully collected legends connected with them, some examples of which we give. It is to be noted that all of them, with the exception of the introductory legend, are connected with the celts in our possession, and are numbered accordingly. The legends themselves have not been repeated by "scholars," or the semi-educated natives, but by most respectable chiefs, who spoke in their own language.

The wicked and malignant fairy of the West African negro is the Anansi or spider, hence their Anansi asems, or Anansi stories. He it was who originally brought disaster on the world, by stealing the first thunder-bolt from Oyankapon (the god of the Ashantis and allied tribes). The story is briefly as follows:—"A very good man, but sorely afflicted, went to lay his troubles at the feet of Oyankapon, and Anansi determined to accompany him and learn what he could of the secrets of heaven. Secreting himself in the woolly head of the negro, he listened attentively to the conversation between Oyankapon and the suppliant. Whilst doing so he saw a curious stone lying on the floor of heaven, and with his usual inquisitiveness wanted to know what it was for. In a second he had stolen it and hid it in his wallet, little imagining Oyankapon had seen him. No sooner had they returned to the earth than Oyankapon made a terrible thunderstorm and shot thousands of these stones down from heaven, with the object of killing Anansi for his inquisitiveness in searching into matters that did not concern him. His agility was so great, however, that he was able to dodge the stones as they fell round him, and escaped unhurt, perhaps because he would not part with the thunder-bolt; but many innocent people were killed. Hence it is that the innocent suffer for the misdeeds of others." The African tale invariably carries a moral, and as the people listen, they cry "Oyea" (very true).

Specimen No. 4. "When I was a young man," said the old chief Ekoom, "I farmed this hill on which the Commissioner's bungalow now stands. One day, after a very bad thunderstorm, I went to my farm, and to



Stone Implements from West Africa.

my surprise saw that a very old tree, which stood in the centre of my farm, had been struck by a thunder-bolt, and was all burnt and charred. This was a bad sign, Oyankapon had killed the tree with his stone from heaven, as a sign that I should work there no more; but, as I looked at the tree I saw embedded in it the stone, and my heart felt good, for I knew that good luck always attends the person who finds a thunder-bolt. And so it proved, my farm became wonderfully productive and I prospered."

Specimen No. 8. "If you tie a piece of thread round this stone," said the aged chief Dontoh (affectionately called by his people Pappa Dontoh), "and place it in a bowl of boiling water, it will foretell, in a wonderful manner, whether a woman in travail will be safely delivered or not. If not, the thread will become loosened and slip off the stone, if she will, it will remain intact." Whether this property was inherent in all thunder-bolts he seemed doubtful. Each had its own peculiarities. He smiled at the suggestion that these thunder-bolts were the work of man. "Did I not see it fall with my own eyes from heaven?"

Specimen No. 24.—"It is not for me to inquire into the ways of Oyankapon," said the chief of Tacorady, "but anyone who says that these stones do not possess wonderful power is a fool. Now look at this one. I found it and I know what it is good for. When I was a young man I used to be a hunter. One day, when I had been very unsuccessful, and was resting under a tree, a heavy thunderstorm came on, and I saw the fire (lightning) strike the ground and dig it up. I went and searched the place and found this stone. After the rain was over I continued searching after game, and shot many. Ever since, when I have taken out this stone in my shot-bag, I have been successful. Now does this not clearly prove that this stone's particular virtue lies in discovering game."

Specimen No. 18.—"My daughter is a grown woman now," said chief Etrue, "but when she was a little girl this stone saved her life. She accompanied her mother who had gone into the Denkera country to sell cloths. Before entering the principal town she discovered a thunder-bolt lying on the ground, and picked it up, as a child always does, to make a plaything of. Her mother was murdered in that country, but the child escaped in a miraculous manner to tell the tale."

Specimen No. 14.—"This stone has been in my family for a long time, and has cured us of many complaints," said another chief. "Once my little son was suffering from weakness, and our native doctors could do nothing for him. Then an old woman told us to soak the stone in water, and make the child drink the water. In no time the little fellow regained his strength."

From a very brief account here given of the superstitions attached to these stones, one would be led to believe that the West African regards them as "fetich," as objects of reverential awe—the conclusion Sir Alfred Moloney came to—but such is not the case. Anyone who has lived among the negroes of Central America and the West Indies (who are the descendants of slaves exported from West Africa), know the ideas prevalent on the subject, viz., that they are lucky objects and nothing more. In exactly similar a manner are they regarded by West Africans.

As a curious illustration relative to the subject, we find that the name of the tutelary god of a large section of the Gold Coast people, Busum, is applied to any small object that takes their fancy, such as a particular shaped cowrie, a pebble, a bean. This is carried about by the individual, for luck, and in gambling he will say, laying down his Busum before him, "Now I am bound to win for there is my Busum." In the island of Jamaica, the descendants of these same people have corrupted the word into Buzo, and the Central American negroes into Guzo. Now here is the name of their sacred god, the god whose name they invoke when taking a solemn oath, used for the idle purpose of a charm. On investigation it will be found that, at all events amongst the Gold Coast natives, thunder-bolts are similarly regarded as lucky objects, and nothing more. This may be considered a fine distinction, but it is the neglect to study these apparently unimportant differences that so often causes us to run away with absolutely wrong ideas of native thought and feeling; complex and involved as it is, we only make the task more difficult.

In conclusion, we will quote the words of an aged chief, which conveys in no doubtful language the position thunder-bolts play in their religious beliefs. He was asked to explain why, if they believed these stones contained miraculous properties, they parted with them. "You may appreciate a thing very highly, yet, when your friend asks it of you, you freely give it, with luck you can get another. But, who in his senses would part with his Souman (the household deity of the individual)? The former anyone, with luck, can procure; the latter, never."

PLANTS AND THEIR FOOD.—VI.

By H. H. W. Pearson, M.A.

The remarkable association for mutual benefit which exists between the root-organisms of leguminous plants and the hosts whose roots they inhabit is not the only one of the kind which must be noticed in connection with the food-supply. As was pointed out in the preceding article, our knowledge of the benefits accruing to either member of the firm as a result of this partnership is incomplete. This is also true of another association between fungi and the roots of flowering plants, which in this case do not belong to the family Leguminosæ.

Many plants, including a large number of Orchids, the Heaths which constitute the larger mass of the plant-population of our moors, as well as many familiar British trees, possess few root-hairs or none at all, their place being supplied by the fine thread-like filaments of the fungus. This so-called "mycorhiza" or "fungus-root" is of two kinds. In many ground orchids and in the members of the Heath family the fungus establishes itself in the external cells of the root whence it sends out into the soil free filaments which serve the purpose of root-hairs. In the Beech and related trees the connection between the fungus and the root is less intimate. Here the filaments do not penetrate the outer cells of the root, but, instead, become closely interwoven forming a mantle over the end of the root, investing it as the finger of a glove invests its occupant. From this mantle proceed numerous filaments which force themselves among the soil-particles after the manner of root-hairs. In most cases little is known of the fungi which enter into such unions with the roots of higher plants. In some, notably in that of the Pine, the mycorhizal filaments belong to the fungus whose fruits are so well known under the name of "truffles." In this association of fungi with the roots of higher plants the benefit is mutual. When the filaments penetrate the living cells of the roots they undoubtedly receive therefrom organic substances which the fungus, being destitute of chlorophyll, is unable to build up for itself.* In return, it to some extent saves its host the necessity of forming root-hairs whose duties are performed by its loose ends. Whether the mycorhiza which simply

* Knowledge, March, 1900, pp. 55 and 57.

invests the root of its host without penetrating its cells is of similar service is not certain.

The mycorhiza is found especially upon roots which grow in soils rich in decaying humus. It is also invariably present in the roots of plants growing in such soil which possess little or no chlorophyll in their stems and leaves, such, *e.g.*, as the ground orchids. It is therefore probable that it is in some way serviceable in supplying its host with such organic substances as are formed during the decay of plant *debris*.† These may be merely conveyed by the fungus in an unaltered condition into the tissues of its host; on the other hand it may be that they undergo within the cells of the fungus such changes as render them more easily absorbed and assimilated by the green plant. It has also been suggested that another, perhaps the chief, duty of the fungus element of the mycorhizal partnership is, in some cases, connected with the supply of suitable compounds of Nitrogen to the more prominent partner. Fungi absorb certain compounds of ammonia—such as are found in the soil—and, by the activity of their protoplasm, build them up into more complex organic compounds. It is at least possible that this may be the nature of the contribution which the fungus makes to the plant in or upon whose roots it lives. But to what extent any or all of these relationships exist between the flowering plant and its mycorhiza can only be determined by future research. At present we must conclude that the true significance of this form of association between green plants and the more lowly organised fungi requires further elucidation; there is, however, no doubt that it is of considerable importance in the economy of nature.

We have now considered the principal sources of the food-supply of green plants and the channels by which it reaches the tissue of the plant where it undergoes chemical alteration into compounds suitable to build up and repair the waste of the vegetable organism. Into the nature of these most interesting changes, as yet but incompletely mastered by scientific investigators, limit of space forbids us to enquire further.

The salient feature of our present topic is the relation between the green plant and its carbon-supply. As we have seen, it is enabled by means of the chlorophyll present in the protoplasm of certain of its cells to obtain all that it needs of that most essential constituent of its food from the Carbon dioxide of the atmosphere. This power is unique, being possessed by no living organisms except such as contain chlorophyll. In the cells of the green plant, as a result of the vital activity of protoplasm in the presence of chlorophyll are produced organic compounds (proteids) containing Carbon and Nitrogen in such a form that they are available as food to organisms—plant and animal—destitute of chlorophyll. Among the lower members of the animal kingdom there are numerous instances of organisms possessing chlorophyll, which therefore subsist partly as plants in that they assimilate Carbon dioxide. As an example may be mentioned the fresh water polype, *Hydra viridis*, familiar to microscopists; in the cells of whose endoderm are found granules of chlorophyll similar to those of the plant-cell. On the other hand, numerous members of the upper classes of the vegetable kingdom have to some extent thrown off their plant nature and have become partly animal in their tastes and habits. Some of them almost entirely, others to a less extent have lost the character which is most pronounced in their nearest allies, and have become destroyers instead of builders up of organic Carbon compounds. These *degraded* members of plant society obtain their supplies of organic Carbon from animals or from other plants, living or dead. Of saprophytes (plants which live upon dead organic matter) we have already said something; it is probable that all plants which flourish in rich humus soils are to some extent saprophytic. It would take us far beyond our prescribed limits to enter here upon a discussion of the interesting features of the life of a vegetable parasite. It must suffice to mention one well-known example—the "Dodder," of which there are three species in Britain; the "Clover Dodder" (*Cuscuta epithymum*, Murr.) is perhaps the best known of these. Its thin wiry leafless stems are destitute of chlorophyll, and are therefore of a dirty yellowish-brown colour. They send short root-like projections into the green juicy stems of the clover from which they derive their entire‡ nutriment. In clover-fields the nearly circular and ever-increasing brown patches caused by the prevalence of this pest over the legitimate crop are, in some seasons, but too familiar. There are degrees of parasitism among plants as elsewhere in the organic world. The Dodder is an example of an advanced type in which the parasite is all but reduced to a condition of absolute dependence. The British Flora contains many plants which rob their fellows of valuable nourishment, but whose parasitism is less pronounced than that of the Dodder.§ Among saprophytic green plants there is a group in which the method of obtaining organic nutriment has led to the development of some of the most remarkable forms in the plant world. There are numerous species of carnivorous plants of which a few are represented in our own Flora. Insects are their chief natural prey; and numerous are the devices for capturing them which plants in the course of evolution have adopted. These may be roughly considered in two divisions.

A large section of the vegetable carnivora are provided with chambers or traps into which the animal is allured, and from which it finds escape impossible. Most interesting examples are seen in two or three species which inhabit the marshes and pools of this country. The Bladderworts (*Utricularia vulgaris* and *U. minor*) are small rootless plants floating freely in stagnant water. The ordinary leaves are much divided into green thread-like segments. In many places instead of leaves are borne pale-green nearly transparent ellipsoid bladders, which vary in different species from $\frac{1}{12}$ to $\frac{1}{4}$ inch in diameter. The entrance to the bladder is closed by a valve opening inwards, and is protected on the outside by a tuft of stiff hairs. Only a very small creature such as can crawl in among the tuft of hairs and, pushing in the valve, can pass through a very small orifice, is able to enter. Once inside there is no escape, for the valve fits close and only opens inwards. The bladders which to minute crustaceans, larvæ of gnats, and other insects, small worms and other inhabitants of stagnant fresh water, possibly suggest refuge, or even food, become chambers of death to those which make trial of them. The prisoner is not killed at once, may even live for as long as six days after its capture; after death the products of its decay are absorbed by the plant by means of short cells somewhat resembling root-hairs which project into the chamber from its walls.

† Knowledge, March, 1900, p. 58.

‡ In the very young condition the Dodder is not parasitic, but quickly perishes if it fails to find a suitable host.

§ Knowledge, March, 1900, p. 58.

There can be no doubt that the small animals thus captured are an important part of the food-supply of the Bladderwort; remains of as many as twenty-four crustaceans have been found in a single bladder at one time. Perhaps the most remarkable of the carnivorous plants which capture their prey in this manner are the pitcher-plants. In some of these the whole leaf assumes the extraordinary pitcher-like form from which the plants get their popular name; in others, as in Nepenthes itself, the pitcher is produced by a metamorphosis of the leaf-stalk, the blade of the leaf being represented only by a small lid which more or less covers the pitcher-mouth. There are about fifty species of these extraordinary plants widely distributed in the warmer regions of the earth. Of these about forty belong to the genus Nepenthes, whose home is in the East Indian Archipelago and the adjacent mainland; there are also a few species in Madagascar and tropical Australia. A splendid collection of living plants is to be seen in the new Nepenthes House at Kew. Other genera are represented in N. America (Sarracenia, Darlingtonia), British Guiana (Heliamphora), and Australia (Cephalotus). The pitchers contain a fluid which in some cases (*e.g.*, Nepenthes) is poured into them from special secreting cells in their walls; in others (*e.g.*, Sarracenia) it is partly if not entirely collected rain-water. They are rendered attractive to insects, in some species, by a honey secretion, and in most by a lurid veining of the sides and top which is distinctly suggestive of animal flesh. An insect once inside is prevented by various devices from escaping, and death by drowning in the fluid contents of the pitcher is therefore its fate. Its remains simply rot in the fluid which is absorbed by the plant, or in the case of some species of Nepenthes their decomposition is hastened by an acid constituent of the fluid produced by the plant itself and secreted into the pitcher. Organic compounds derived from the bodies of the animal prey are thus set free and are absorbed into the plant and constitute an important element of its food-supply.

A second class of insectivorous plants is exemplified by another well-known British plant, the beautiful little Sundew, of which three species inhabit bogs and wet places. These and several others to which we are unable to refer here exhibit movements of various kinds in the capture and "digestion" of their insect prey. In the common Sundew (*Drosera rotundifolia*, Linn.), a small plant with a rosette of leaves growing close to the surface of the ground, the leaves are circular, from ¼ inch to ½ inch in diameter and attached to the plant by long stalks. The upper surface of the leaf is thickly beset by curious little tentacles terminating in swollen reddish heads, which secrete a colourless sticky fluid. This fluid, glistening like dew in the sunlight, gives to the plant its popular name. A small insect, attracted doubtless by the appearance of honey, alights upon the leaf and is unable to extricate itself from the sticky exudation. Now occurs a wonderful series of movements.[§] The tentacle or tentacles touched by the insect slowly curve over until the victim is thrust down between them upon the flat surface of the leaf. At the same time all the tentacles in the neighbourhood begin to curve and converge towards the same point. The smothering of the prey is thus complete, and its body is quickly decomposed by the acid secretion poured upon it from the cells of the tentacle heads. Its proteids are thus rendered soluble and are absorbed by the leaf. In the case of Drosera it has been experimentally proved that the plant thrives better when it is able to obtain animal food than under other conditions.[¶] These examples of the better known carnivorous plants must suffice. They are so remarkable that it is not unlikely that too much importance may be ascribed to this curious habit. It must be borne in mind that although some plants have adopted these practices they represent but a very small part of the immense group of green plants. This method of obtaining Carbon and Nitrogen from the animal body is an abnormal development which is of comparatively little importance in the plant-world as a whole.

[§] In *Drosophyllum lusitanicum*, Link, a native of the Peninsula and Morocco, the process of capture is the same as that described for Drosera, except that the stalked glands (tentacles) are incapable of movement.

[¶] F. Darwin. *Journal of the Linnean Society*, Vol. XVII., pp. 23 and 599.

THE GREAT TELESCOPE OF PARIS, 1900.

By EUGENE ANTONIADI, F.R.A.S.

IT was at the initiative of M. François Deloncle, plenipotentiary minister, that a group of amateur astronomers decided upon devising for the Paris Exhibition an instrument of exceptional size, far transcending anything that had been before achieved in that line. With this end in view, it was agreed to give to the object glass a diameter of 49.2 inches, that is 9.2 clear inches more than the Yerkes glass at Williams Bay, Wisconsin, and 13.2 inches more than the Lick refractor. Meantime, in order to check, as far as possible, the defects of spherical and chromatic aberration, it was resolved to give the lens the immense focal length of nearly 200 feet.

To mount such a leviathan on an equatorial foot would practically be an impossibility. For to say nothing of the tremendous weight of the tube, and the consequent instability and flexures to which it would be exposed, the protecting dome ought to have a diameter of at least 210 feet, thus surpassing by 72 the cupola of St. Peter's, in Rome, and by 103 feet the dome of St. Sophia, Constantinople. Owing, moreover, to the apparent diurnal swing of the heavens round the Pole Star, the dome ought, during observation, to be in constant motion, so as to keep its opening constantly in front of the object glass, speeding with a velocity of some 50 feet an hour; the eye-piece, too, would have to fly at a comparable

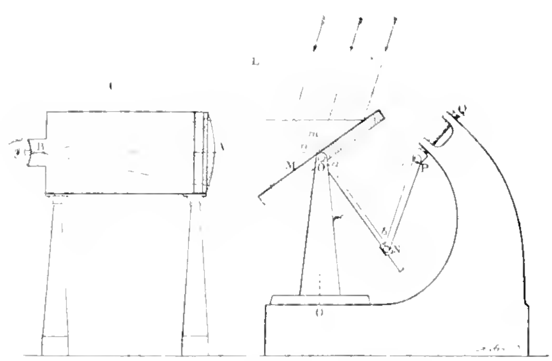


FIG. 1.—Principle of the Siderostat.

pace, and it is needless to point to the inconvenience to which the velocity of such motion would subject the observer.

In order to surmount these various obstacles it was wisely decided that the mounting be that of the siderostat, such as perfected by Léon Foucault, a man of remarkable mechanical ingenuity. The siderostat is an old invention. During the eighteenth century, Parrault had already constructed a mechanism based on the same principle, while "in 1799," says Lalande,* "an able London optician, named Brown, made a telescope whose tube is always horizontal, and in which a plane mirror reflects the image of the object into the eye-piece."

The siderostat thus consists of a plane mirror, M (Fig. 1), moved by a clockwork motion communicated to the axis PQ, parallel to the axis of the earth, and two axes, a horizontal axis at right angles to the paper at O, and a vertical axis OO′. At the back and centre of the mirror's cell is fixed a rod, ON, on which glides a muff, N, held by a fork, PN, attached to the polar axis. The length of the fork, PN, being equal to the distance OP, the triangle NOP is, in all positions of the mirror, isosceles, and $\angle a = \angle b$. But $\angle a = \angle n = \angle m$, the angles of reflection and incidence. Hence $\angle m = \angle b$, and thus the direction of the fork PN is always parallel to the incident ray.

Now, in virtue of the problem of revolving mirrors, the angular velocity of the mirror is one half that of the celestial sphere. This is obtained by imparting to

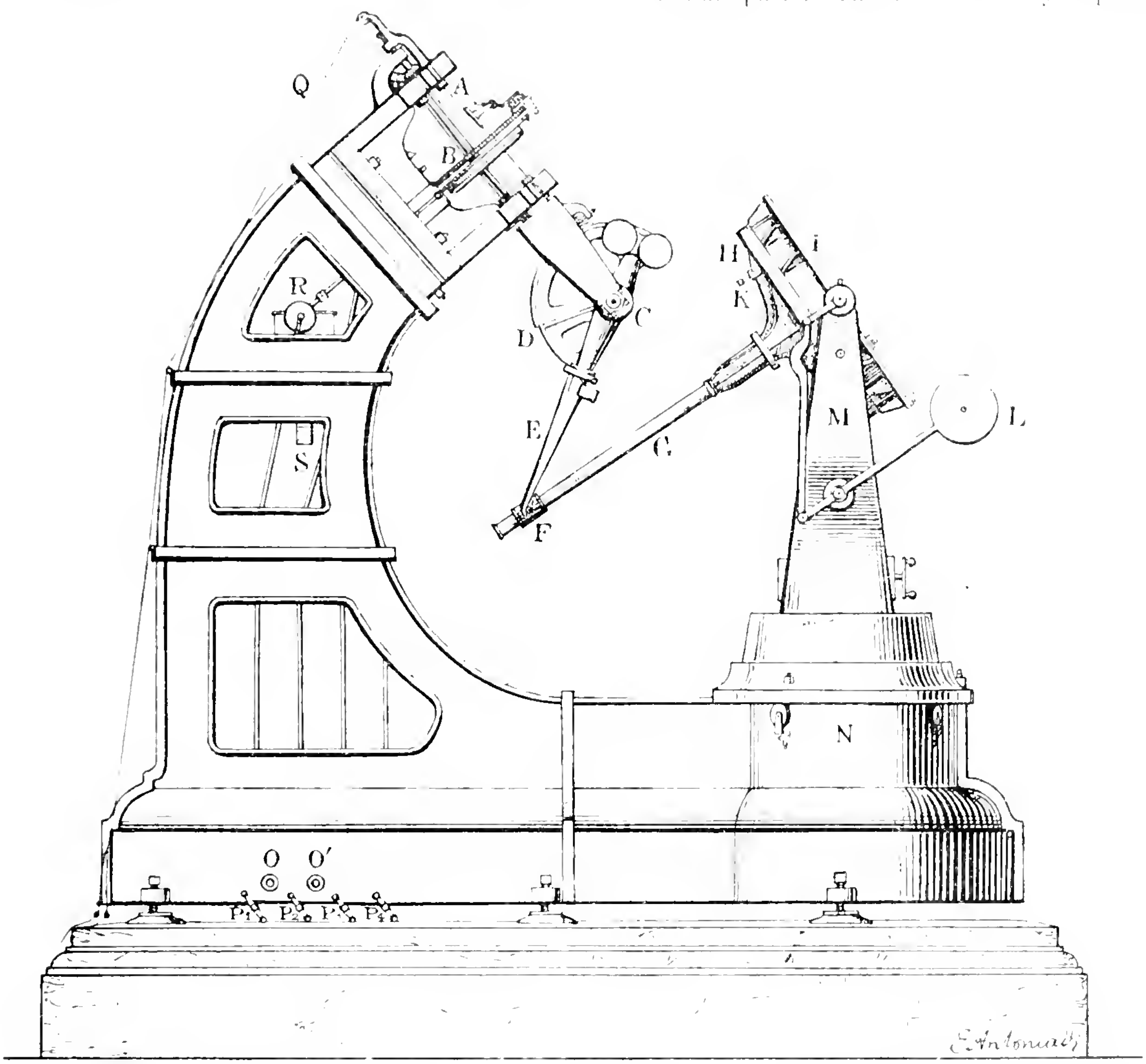


FIG. 2.—The Great Siderostat of Paris, 1900. A, Right ascension axis; B, Right ascension circle; C, Declination axis; D, Declination semi-circle; E, Fork attached to the declination axis; F, Muff held by the fork; G, Brass rod fixed normally to the mirror's cell; H, Cell of the mirror; I, Silver on glass mirror of the siderostat; K, Screw allowing of the mirror being taken out of the cell; L, Counterpoises equilibrating the mirror; M, Great forked support of the mirror; N, Cylinder containing mercury, enabling the floating of the mass M; O, Telescope for reading the divisions of the right ascension circle; O′, Telescope for the declination circle; P_1, Handle for slow horary movements; P_2, Handle for rapid movements in right ascension; P_3, Handle for motion in declination; P_4, Handle for winding the clock; Q, Strings for clamping and unclamping in right ascension; R, Clockwork motion; S, Weight of the clock.

sending the reflected beam along the optical axis of a fixed telescope, AB.† The mirror is moveable round the axis PQ a double velocity, so as to make it rotate once in 24h. Inasmuch as the centre of rotation of the mirror is at O, and not in the middle of NO, its rotation is twice slower than that of the axis, being effected once in 48h., since an angle at the circumference of a circle is one-half the angle at the centre.

* Quoted by Delaunay, *Cours Élémentaire d'Astronomie*, 7e éd., p. 174

† For clearness's sake, the refractor has been monstrously shortened on the above diagram.

The Paris siderostat is shown on Fig. 2, which was specially drawn for the readers of KNOWLEDGE. Its total length is 27 feet and such is its height also. It weighs, moreover, some 45 tons. The glass mirror itself, whose diameter measures $78\frac{3}{4}$ inches, or more than $6\frac{1}{2}$ feet, and whose thickness is 11 inches, weighs $3\frac{3}{4}$ tons. It is held in equilibrium by a system of levers and counterpoises, and rolls in a cylindrical well containing 22 gallons of mercury. The volume of the submerged part was so calculated that the weight borne by the mercury is nine-tenths of the joint weight of the mirror and its support, that is, nearly 13 tons.

This description of the mechanism will be rendered clearer by an inspection of Figs. 3 and 4, showing the axes, circles, forks, and mirror of the siderostat, while the Plate gives a general frontal view of the instrument.

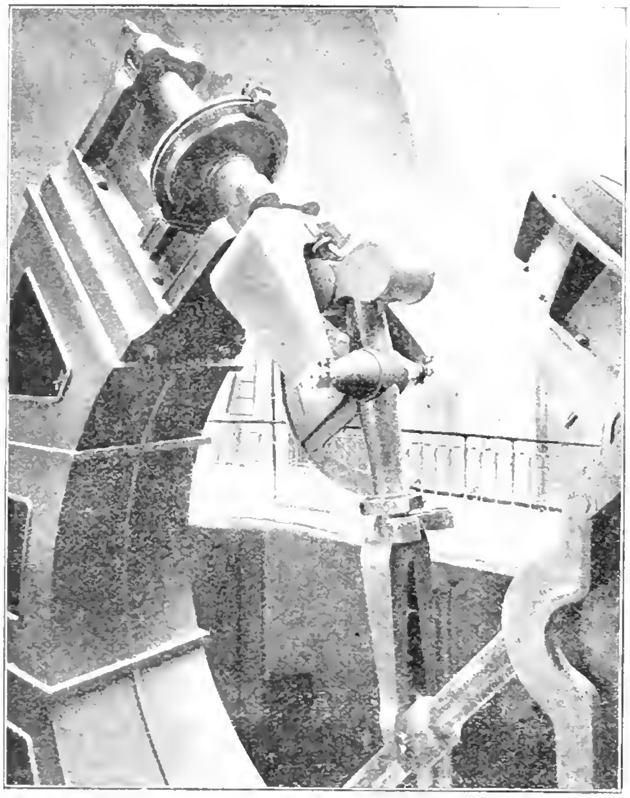


FIG. 3.—Right Ascension and Declination Axes and Circles of the Great Siderostat.

The mirror was cast by M. Despret, in June, 1895, at the glass works of Jeumont. The object glass was cast by M. Mantois, while all the mechanical part of the apparatus, including the figuring of the optical surfaces, was made by M. P. Gautier, optician to the Paris Observatory, whose plans were carried out thoroughly by M. G. Allix, a workman of great skill.

It was no easy task to polish the surfaces of the colossal mirror and of the lenses of the object glass. For this, M. Gautier had to devise a new method. The grinding action of two flat metallic sliders gave to the mirror its flat surface, while the same process was used in figuring the object glass; owing, however, to the slight curves to be given to the surfaces, the slides, instead of being straight, presented the curvature of the disks. The rectilinear motion of the system thus developed gave rise to a cylindrical section, which, however, in virtue of the rotation of the lenses round their axes was transformed into a spherical surface.

In testing the mirror, M. Gautier followed Foucault's process, which consists in examining telescopically the

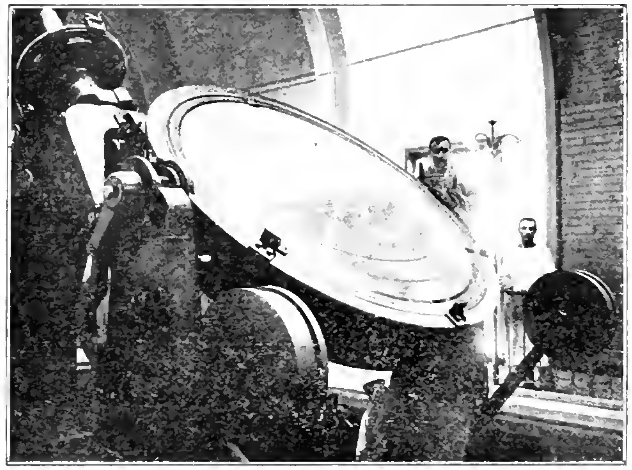


FIG. 4.—The Great Mirror, 79 inches across.
(*Photographed by M. G. Mathieu.*)

image of a point of light reflected from the mirror. If the surface be quite plane the image reduces itself to a small luminous circle surrounded by concentric diffraction rings. If the portion of the surface under scrutiny is slightly concave, there will be a flattening of the image in the vertical direction, when pushing the eye-piece in, and it will be elongated in the same direction when drawing the eye-piece out. Should the surface be slightly convex, the reverse would take place.

While making these experiments, M. Gautier noticed that the mirror's sensibility was such that by merely

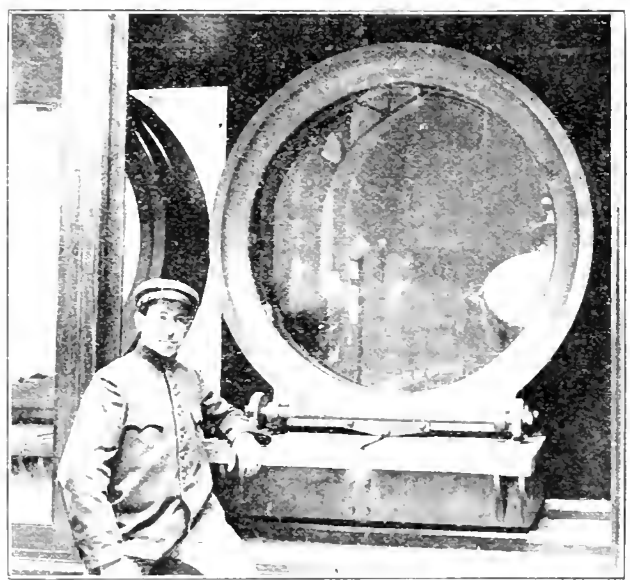
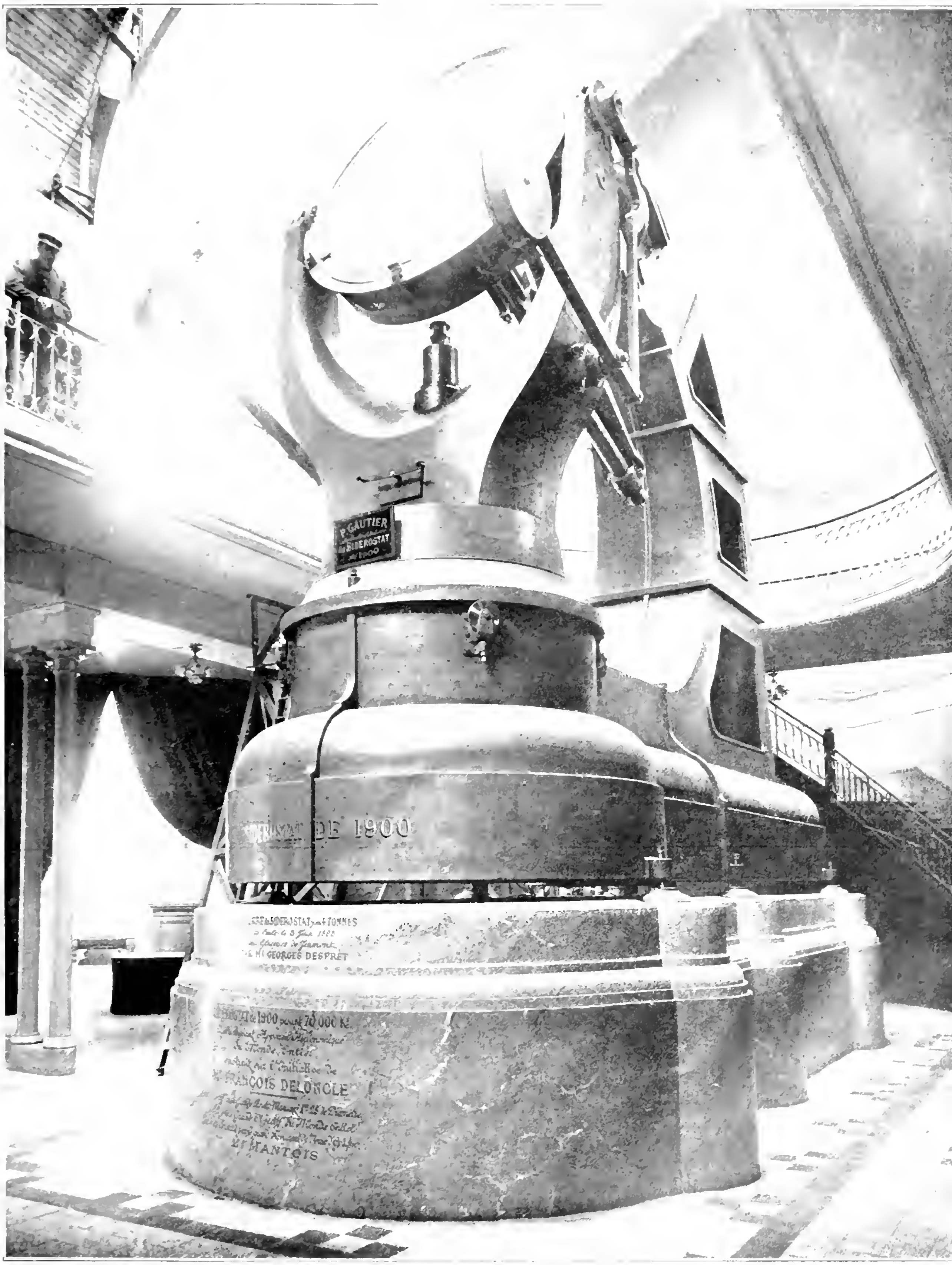


FIG. 5.—The Object Glass of 49·2 inches.
(*Photographed by M. G. Mathieu.*)

touching the surface with the hand he produced a protuberance deforming the telescopic image at that point, and which, measured with the spherometer, attained $\frac{1}{75000}$ of an inch. The spherometer, meantime, enabled the detection of irregularities in the plane surface, not exceeding $\frac{1}{250000}$ of an inch.



THE GREAT SIDEROSTAT OF THE PARIS TELESCOPE.

The cylindricity of the axes and rollers of the siderostat was verified with an accuracy of [illegible] of an inch.

The diameter of the object glass, which is a photographic one, measures, as above stated, 49.2 inches, and its weight is 791 lbs. But the clear aperture is 47.2 inches, and the focal length some 187 feet. Hence the photographic images of the sun or moon in the primary focus measure from 21 to 22 inches across.

The tube of the telescope is 180 feet long, and 59 inches broad. It is of steel, rather less than $\frac{1}{10}$ inch thick, and weighs 21 tons. The total weight of the instrument, including the siderostat, thus falls but little short of 70 tons. The tube rests on five cast iron supports, besides the two other supports, one at each end.

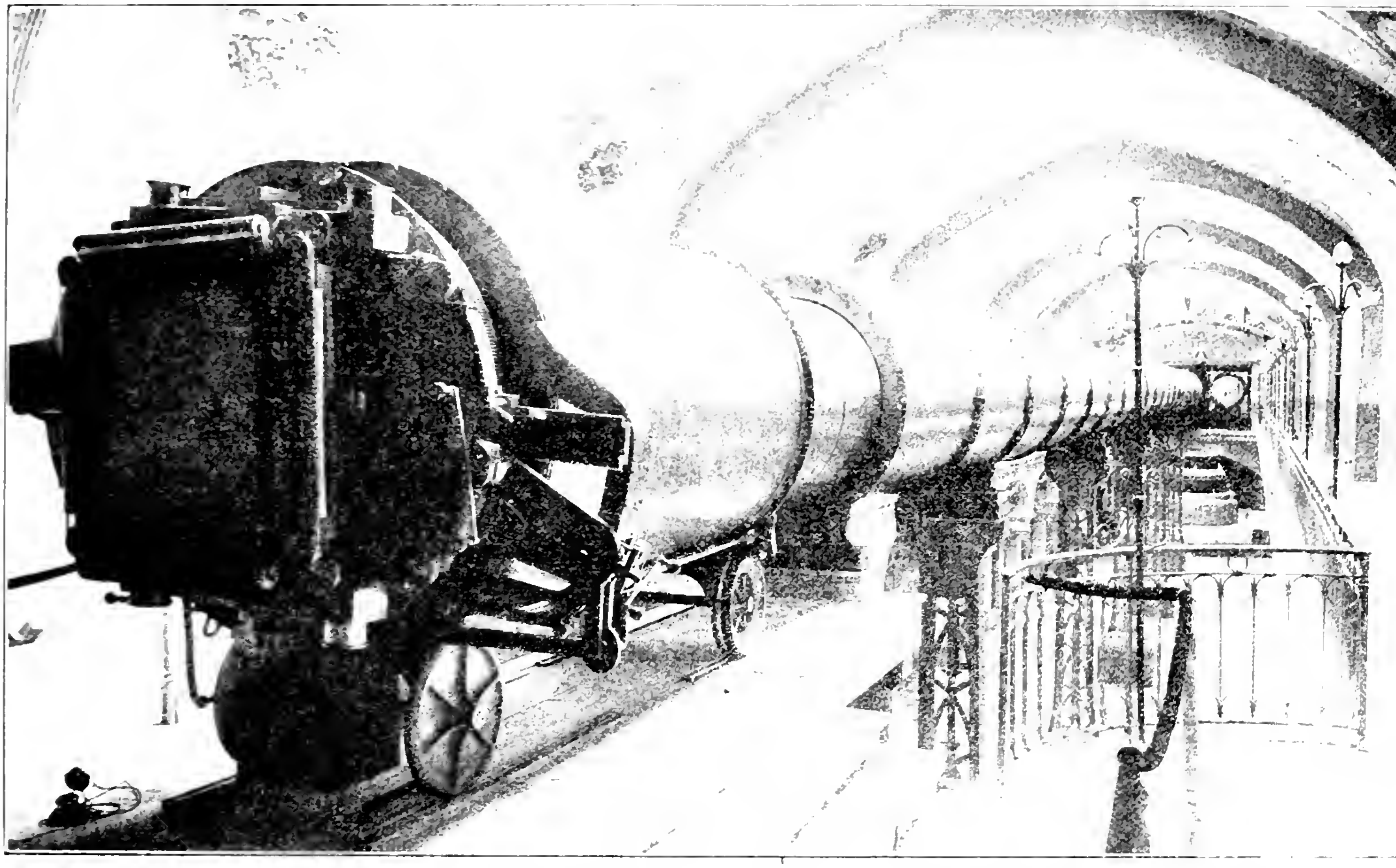


Fig. 6.—General View, showing the eye-end, of the Great Telescope, as mounted in the Palais de l'Optique at the Paris Exhibition.

A short tube, of the same breadth as that of the telescope, but resting on four wheels, forms the eye end. The wheels can glide along a railway, so as to facilitate the focussing of the plate or eyepiece, which would otherwise be extremely inconvenient, seeing that the weight of this eye end is also counted in tons.

Fig. 6 gives a general view of the telescope with the eye end, as mounted in the Palais de l'Optique, Champ de Mars, at the Exhibition.

All heavenly bodies have to be found by their right ascension and declination. There is no possibility of directing the mirror's motion from the eye end. Hence the helpless observer at the eyepiece is to some extent "at the mercy" of the astronomer in charge of the movements of the siderostat, [illegible] feet off, with whom, however, he can communicate telephonically.

Compared to the Yerkes telescope, the light grasping power of the Paris refractor is as about 2¼ is to 2, in favour of Paris, due allowance being made for the loss of light (8 per cent.) by reflection on the silvered mirror. The stellar penetration of the siderostat ought, therefore, to reach the 18th magnitude.

It was through M. Flammarion's kindness that the writer was enabled to utilize the Paris siderostat.

The planets Jupiter and Saturn were unfortunately out of reach beyond 20° of south declination, inasmuch as it was not thought safe by the maker to allow the mirror to make a smaller angle than 12° with the vertical.

Venus, however, was well situated during the summer, and the writer was enabled to secure a considerable number of drawings of her at daytime. The great telescope showed the planet utterly destitute of detail (Fig. 7).‡ Its appearance was that of a pale yellow crescent or half-moon, with a brighter limb, projected on the dark azure of the sky. Hence the inanity of all rotation periods based on the observation of subjective spots, and fixed sometimes (as in the case of M. Brenner) with the accuracy of one ten-thousandth of a second!

‡ It will be noticed that owing to the mirror's reflection, the images are inverted east and west. The focus, moreover, for Venus in the great refractor was some ten or fifteen inches further out than that of stars or nebulæ.

The great light-grasping power of the Paris refractor next proved, as was naturally to be anticipated, wonderfully efficient on nebulæ. Though these delicate objects

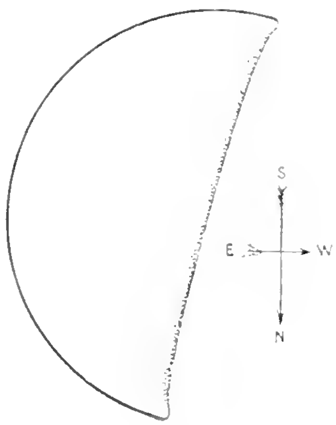


FIG. 7.—The Planet Venus, as seen in the Great Siderostat on 1900, September, 15d. 11h. 40m. G.C.M.T.

require, in order to be advantageously scrutinized, (*a*) a minimum of luminous absorption on the part of the refracting medium, (*b*) a maximum of darkness of the sky, and (*c*) a good definition; and though, on account of the dust, smoke, illumination, and perpetual mixture of air masses of different densities, none of these con

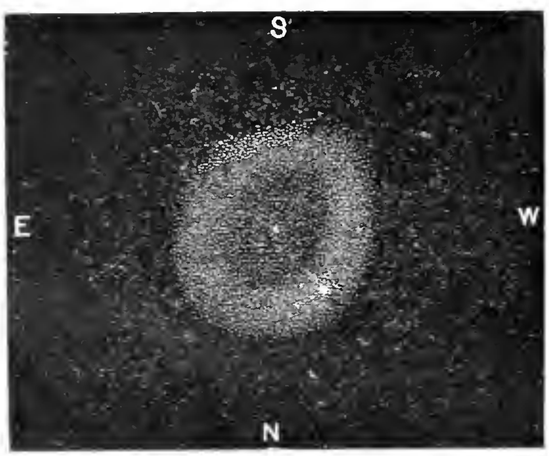


FIG. 8.—Annular Nebula H IV. 13 Cygni, 1900, July 17.

ditions was fulfilled at the Exhibition, the results already secured in this line are very satisfactory indeed.

Thus in the annular nebula H IV. 13 Cygni the siderostat showed, probably for the first time *visually*, the faint central condensation visible on Dr. Isaac Roberts' beautiful negatives, and which is not shown on the drawing published by Lord Rosse II. in his "Observations of Nebulæ and Clusters of Stars made with the 6 foot and 3 foot Reflectors at Birr Castle, from 1848 to 1878," Part III., Plate V. The annulus is, moreover, distinctly elliptical from north-east to south-west, and not round as has been shown heretofore. A faint haziness fills the interior of the ring (Fig. 8).

The spiral structure of H IV. 16 Sagittæ was easily detected with the siderostat, though it was rather hard to say whether the object was a right or left-handed spiral (Fig. 9).

No less interesting was the appearance of the Saturn-like planetary nebula H IV. 1 Aquarii (Fig. 10). In a paper read before the Royal Society on June 20, 1850, Lord Rosse I. described this object thus:—"It has ansæ, which probably indicate a surrounding nebulous ring

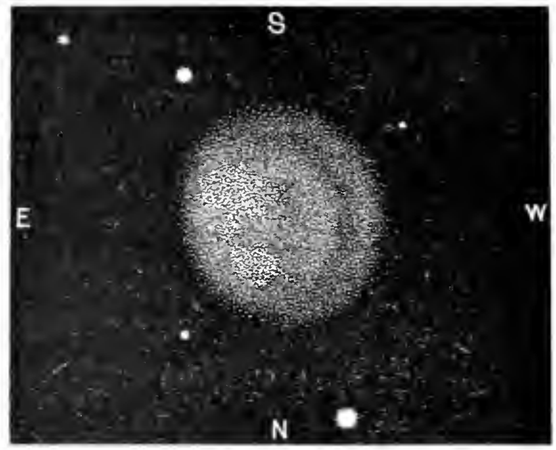


FIG. 9.—Spiral Nebula H IV. 16 Sagittæ, 1900, July 26.

seen edgeways."§ His drawing of H IV. 1 is very remarkable, as showing the nebula in the form of the planet Saturn, flattened at the poles and with a scarcely opened ring—which is also its appearance in the Paris refractor. But the rows of dots shown by Lord Rosse in the body of the nebula, and the rays shooting from it are invisible in the siderostat, and the writer fears that these details are not of an objective character.

We append, in conclusion, a drawing of the central regions of the Andromeda nebula, as seen with the

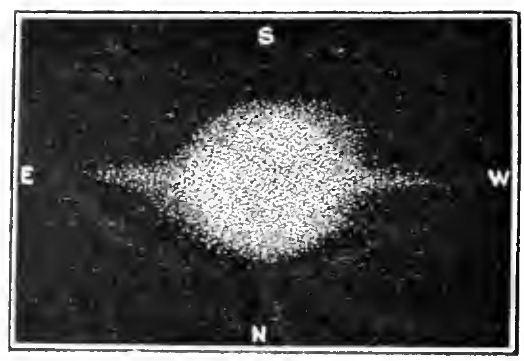


FIG. 10.—Planetary Nebula H IV. 1 Aquarii, 1900, July.

siderostat on September 1 last (Fig. 11), and in which flashed in 1885 the well-known bright temporary star. It will be seen that the nucleus is nebulous at present, and that there is not the slightest indication here of a stellar condensation. It is, moreover, strongly elliptical and not circular, following in this the form of the great nebula itself.

Such are a few of the results obtained with the new siderostat in the midst of Paris in 1900. But it is not in the dust and smoke of great cities that large telescopes show their full power, so that the day when we hear that the huge refractor has been remounted, fully prepared

§ *Philosophical Transactions*, MDCCCL., p. 507.

and equipped, on some well-selected eminence, far from industrial centres, then may we look forward to having probably more cogent proofs of its superiority over the telescopes made to the present time.

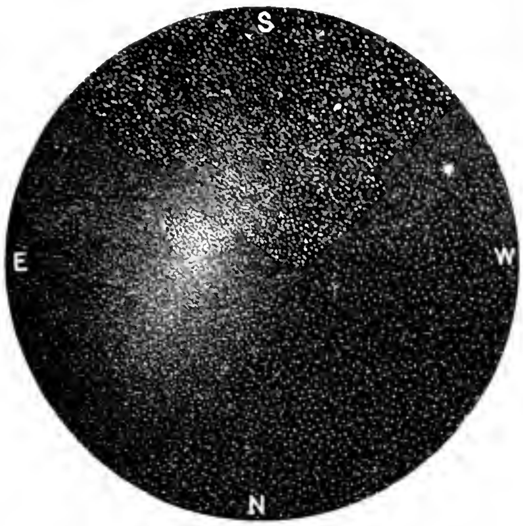


Fig. 11.—The Nucleus of the Great Nebula in Andromeda (M 31), viewed with the Great Telescope on 1900, September 1. (Field of 4'.)

ASTRONOMY WITHOUT A TELESCOPE.

By E. Walter Maunder, f.r.a.s.

X.—THE METEORS OF NOVEMBER.

There can be no doubt as to the appropriate subject to which to call the attention of the "astronomer without a telescope" in this present month. Two great periodical meteor showers come to their node at this time, and all the circumstances of the case should combine to attract the attention of the observer. The possibility that we may have a display which by its mere magnificence would most fully reward the watcher, will perhaps be the point which appeals to the greatest number. A far higher claim is to be found in the number of important questions connected with the two showers, and especially with that of the Leonids, which still wait further observation for their settlement.

So much has been written the last year or two about the great Leonid shower that there is little need to go much into detail. The history of the shower goes back 1000 years to October 12, 902 A.D., a sufficient number of records being extant between this date and November 11, 1799, to show that the shower came in great force on an average three times in a century, and that the day of the shower was moving slowly onwards in the year. The astonishing display which took place on November 12, 1833, which from the accounts preserved would seem to have been the most impressive astronomical spectacle ever witnessed, proved the birth of meteoric astronomy, and the labours of Prof. Newton and Prof. Adams established the fact that the shower was due to an immense swarm of meteors travelling in an elliptic orbit round the sun in a period of $33\frac{1}{4}$ years; while Prof. Schiaparelli showed that Tempel's Comet, 1866, I., moved in practically the same path.

The great shower of November 13, 1866, added much to our knowledge, and important but less abundant displays were seen in the two following years. After 1869, conspicuous showers from the radiant in Leo ceased, but trained meteor observers have hardly ever failed to notice a few characteristic meteors from this point of the heavens on November 14, or the nights immediately preceding and following.

As there appeared to be a slight increase in the number of meteors as early as 1896, public expectation of a repetition of the grand spectacles of 1833 and 1866 began to be excited in November, 1898, and the interest was increased the following year. It is matter of history that on neither occasion was there anything to answer expectation; a few Leonids indeed were seen, but nothing which by the utmost stretch of language could be described as a great shower. The reason of the failure is matter rather of conjecture than of knowledge. Dr. Johnstone Stoney and Dr. Downing consider that the orbit of the meteors has been so far perturbed that the main stream now passes clear or nearly clear of the earth's orbit, and that our chance of seeing a fine shower from Leo this year is less even than it was last. Our knowledge, however, of the condition of the meteor stream is so slight that we are scarcely justified in hazarding any prophecy. We have gauged the stream at various intervals in its enormous length, but inasmuch as we have never succeeded in seeing the stream in the open sky, we know nothing of it except from the members of the swarm which we actually encounter. In other words, we know nothing of the stream except of such portions of it as the earth has already destroyed. We have, therefore, no right to give up hope of the return of the shower until the fateful days are come and gone.

Should the Leonids revisit us in force either this year or in 1901, the simplest, and for the inexperienced observer, the most useful observation to make, will be that of counting. Counts may be made in two ways. A watch may be kept for a definite time—five minutes, ten minutes, or a quarter of an hour—and the number of meteors seen in that time noted; or starting from a chosen instant, a watch may be kept till ten, twenty, or thirty meteors have been observed, and then the time taken again. The result of the observation in either case should be given at the rate of so many meteors an hour. The observer will find it well to select a definite portion of the sky for his work, carefully recording the boundaries which he assigns to himself; bright and well known stars should be chosen to mark the limits of the field he is scrutinizing. If three or four observers can work together, the entire sky should be divided between them.

The special object of these counts in the case of a great Leonid shower would be to determine whether the stream still appeared, as on several former occasions, to be divided into three distinct sections, the middle or principal section being separated from those preceding and following by a nearly quiescent interval of about six hours. The counts would suffice to show whether the stream was still divided into the same three sections, or whether it had become still more complex in character, and it would also furnish an index of the relative richness of the different portions.

For those who have some experience in meteoric work the most important duty would be the noting of meteoric paths. This work should be carried on over as long an interval as possible, the object being to get good and sharp determinations of the radiant at successive hours during the night in order that if possible the effect upon the apparent radiant point of the rotation of the earth may be made clear. This work had, however, be best left to those who have already gained some experience in this branch of observation, the Leonid meteors being amongst the swiftest that we encounter, since they come to meet the earth, their relative velocity being some forty-four miles per second, the sum, that is, of the actual orbital speed of the meteors, twenty-six miles, and of the earth some eighteen miles. The phosphorescent streaks, due no doubt to this swiftness of motion, which they leave behind them in their path, are, however, a great assistance to the beginner.

The moon, which reaches its last quarter in the early morning of the 14th instant, will, therefore, interfere very little with the effect of the Leonid shower should we be favoured with a fine one this year, and it will have passed to conjunction with the sun before the second great shower of the month, the Andromedes, reach their node. They furnish in all respects a great contrast to the Leonids. The Leonid radiant does not rise on November 14 until 10.30 in the evening; the Andromede radiant is up the entire night, being nearly in the zenith when the Leonid radiant is rising. The Leonid meteors are extremely swift; the Andromedes are very slow. The Leonids are distinguished by their green colour, suggesting the presence of magnesium; the Andromedes are rather yellow, as if sodium were their chief constituent.

The history of the Andromedes is as well known as that of the Leonids. Whilst the latter approach the sun as nearly as the earth's orbit at their perihelion, and recede somewhat beyond the orbit of Uranus at aphelion, the Andromedes only recede about half-way between the orbits of Jupiter and Saturn. Their period therefore is one of $6\frac{1}{2}$ years as compared with the $33\frac{1}{4}$ of the Leonids, and the greatest showers that we have had from them in recent years have been in 1872, 1885, and 1892. The shower of November 27, 1872, was one of peculiar interest, inasmuch as it was then clearly recognised that the swarm was moving along the same orbit which had been travelled by the lost comet of Biela, the comet which divided into two portions in December, 1846, and which has never been seen since its return, still in two portions, in 1852.

Whilst the Leonid shower has been falling gradually later and later in the year, so that November 15 is now its date of maximum, the Andromedes, or Bielids as they are indifferently called, have moved from November 27 to November 23. This present year is not one in which we have reason to look for the full force of the Andromede shower, but it may well give good practice to the beginner in meteoric observation. The observer should by all means try to record as many paths as possible, the radiant on former occasions having appeared to be rather an elliptic area than as a definite point.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

A NEW FORM OF ACHROMATIC TELESCOPE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—A new and original method of correcting chromatism in the combination of lenses suitable for telescope objectives, etc., and for materially reducing the length of such instruments, has been devised and successfully demonstrated by two of the members of the Toronto Astronomical Society; the Messrs. Collins.

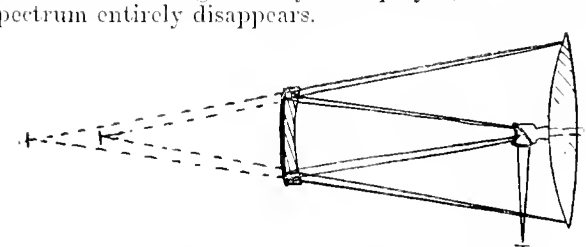
The method consists essentially of interposing a small concavo-convex lens, silvered on the back, in the path of the converging cone of light that has passed through a large single convex object glass, preferably midway down the cone, both lenses being of the same medium of the same refractive index, the small concavo-convex lens having the requisite curvatures to give an equal amount of dispersion in the opposite direction to that produced by the single object glass. After penetrating the correcting lens the otherwise scattered points of light are reflected back from the silvered surface, and brought to a focus at a point slightly in advance of the object glass. A total-reflection prism or a flat intercepts the converging cone before it reaches this point, as in a Newtonian reflector, and throws it to one side, where the image may be examined by an eye-piece, received on a photographic plate, or projected on a screen.

As the positive dispersion of the object glass and the negative dispersion of the corrector are of equal and opposite amount, the dispersive effect entirely disappears and an absolutely achromatic image is formed. Spherical aberration is controlled by the curvatures of the first objective, and the dimension of field by the size of the prism. A total-reflection prism-lens, of the same refractive index as the others, may be substituted for the flat prism, and thereby amplify the focus to any extent that may be required; the curvatures of the small corrector may be changed to correct for the prism-lens, and the latter in turn be made to correct for uniformity of dimensions of all the component colour images, thus delivering to the eye-piece an image focussed entirely on a single plane with component colour images of precisely uniform dimensions on a comparatively wide field.

The shadow of the flat or prism falls on the concave first surface of the corrector, is reflected back, opens out and covers itself, thus preventing reflections from this surface entering the eye-piece to flare the field.

The present field with a 4 in. objective is 4 in. diameter.
" " " 8 " " 5 " "
Diameter of prism with a 4 " " $\frac{7}{8}$ " "
" " " 8 " " 1 " "

Glass of different refractive indexes may be used, but when one kind of glass only is employed, the secondary spectrum entirely disappears.



Collins' Monoplane Achromatic Telescope.

A sketch of the optical part of the experimental instrument that has been made is attached herewith.

W. B. MUSSON,
Secretary, Toronto Astronomical Society.

ARTIFICIAL FACULÆ, SPOTS, AND PHOTOSPHERIC RETICULATION.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—If in this letter I take the liberty to address you at some length on the above subject, my one plea must be the articles contributed to your valuable journal at various times by the Rev. A. East. These articles involve issues which it is impossible to compress into the ordinary space of a letter.

I cannot help recurring to the footnote which Mr. Maunder appended to Mr. East's article on artificial sun-spots in the December (1897) issue of Knowledge. Undoubtedly instructive as Mr. East's experiments are, he allows himself to be carried too far in drawing conclusions and pointing to analogies between solar phenomena and a peaceful domestic experiment. It seems to me nothing short of extraordinary on the strength of this latter to even doubt the convertibility of maximum sun-spottedness and maximum solar activity. To be thus, after many years of independent study with telescope and spectroscope, confronted with the proposition that maximum spottedness is synchronous with solar quiescence is upsetting accepted theories with a vengeance.

I have no desire to be flippant, having the subject too seriously at heart, but to come now, in the face of all the information gained as to coincidence of spots, prominences, faculæ, aurorae, and magnetic storms, vivid reversals of spectral lines and distortions, and upset all this because of heating some stuff in a boiling pan, is going too far. Certainly may we believe that solar phenomena are different to their known terrestrial *confrères* in their intensity only, but where are in Mr. East's experiments the stupendous potentials of temperature, pressure, chemical affinities, tremendous velocities, and the host of incidental physical conditions of which we have hardly a proper conception? These solar conditions possibly involving natural laws, which are for ever hidden from human knowledge. But to touch directly on the matter under discussion.

I do not believe for one moment that the actual or visual appearance of the photosphere influences spot formation, but, if anything, that spots about to form influence the appearance of the photosphere locally. Mr. East mentions that *compactness* of the photospheric material favours spot appearance, and yet again says, that the solar poles will never show spots "for there the photospheric matter will always be too closely packed." What are we to make out of such inconsistent arguments? Incidentally I may mention that Mons. Janssen is more reserved as to a different construction of the reticulation of the photosphere in the polar regions as compared with that in the lower latitudes. He says on page 113 of his excellent work:—

"Nous n'avons pu, jusqu'ici, trouver de différences appréciables entre les regions qui, sur ces images, environment le pôle et celles des regions équatoriales."

"Il parait donc, jusqu'ici, que le phénomène de la granulation est un phénomène général à la surface de la photosphère, et qu'il n'est pas en dépendence immédiate avec celui des taches."

No doubt, as Mr. East says, the photosphere is torn and churned and dispersed, but by what? I venture to say by spots, and all the other eruptive phenomena connected with them, and that therefore the maximum disturbance of the photosphere is reached practically at the same time as the spot, faculæ, and prominence cycle reaches also its maximum. Certainly the sea may be violently disturbed also after the storm has passed, but still it is not conceivable that the disturbance reaches its maximum much after the storm is at its climax. The passage from solar maximum activity to minimum is a very jerky process, and the present minimum is a strong case in point, inasmuch long after maximum spot activity, that is, *after* the photosphere is so unfavourable to spot formation, we have had spots of extraordinary size and ditto prominences accompanied by auroral display as late as September, 1898. In short, to my lay mind it is impossible to imagine that at a time of maximum solar activity I should for consecutive days direct the telespectroscope towards the sun, see no spots and faculæ, and find the edge of the disc as smooth almost as on a turned flywheel.

The argument Mr. East uses to support his view, viz., the coincidence of the spot and prominence maxima, is also open to objection. Mr. East argues that "when the photosphere is diffuse, the solar flames will have but little altitude, when compact all the force is concentrated at the openings of the spots and vast jets of flame are expelled." First let me say that prominences, as a rule, do not issue out of the spot cavity, as this sentence would lead the reader to assume. Furthermore, according to this thesis, one must expect to see the tallest prominences in the polar regions, as there the photosphere is closely packed, as he states elsewhere. My own observations confirm what Prof. Young states, namely, that eruptive prominences appear in the immediate neighbourhood of spots and never near the poles.

When I look over Mr. East's article in general, I must confess I am unable to see what he is desirous to establish or driving at, and his conclusions drawn from his experiments are far from convincing. Again, Mr. East's conception of the origin of prominences, which he illustrates by another experiment, puts a limit to the appearance of these eruptions which is out of all agreement with actual observation. His prominences must all be of one "style" and almost tediously alike, and only different in height at various periods.

There is one point in Mr. East's studies the value of which I set far above his comparisons and conclusions, and that is that he keeps along a line which centres in the assumption *that the causes of solar evolution are to be found on the sun itself*.

As to a satisfactory explanation of the periodicity of spots, etc., no satisfactory solution has come up yet, nor, I venture to say, *ever will*, making respectfully all allowance for future progress of science. We have had the influence of the planets or the periodic return of a large aggregation of meteorites close to the sun as special favourites, but all these propositions carry with them a great deal of doubt and little conviction. As we see the periodicity to be variable to an average extent of two years for *successive* minima and maxima, it is only likely that these two theories will break sadly down. Since to my mind the cause of the cycle is to be found on the sun itself, and is to my conviction contained in the solar contraction and the contending forces set up by it, it is not difficult for me to conceive that successive pulsations cannot be at exact intervals of time, and, as Mr. East says, each successive disturbance is influenced by the greater or lesser intensity of the preceding one. The very magnitude of the sun's proportions seems to imply a rhythm of pulsation appropriate, and if 11·11 years have been found to represent the average of these periods, it is quite reasonable, if perhaps not very scientific, to simply accept this fact. We never seem to trouble our heads much about finding out how it is that the earth takes about 365 days for completing her orbit, or why the sun rotates once in about 25 days, and similar unsolvable problems.

Albert Alfred Buss.

9, Grosvenor Square, Ashton-on-Mersey.

[May I point out that there is no inconsistency of argument as to the absence of spots at the solar poles, the contention being that a certain compactness of the photosphere is necessary for the formation of the spots, and that if this condition of the photosphere is wanting, either from *excess* or *defect* of compactness, no spots will form: at the poles, it is suggested, there is excess of compactness. But let me hasten to mollify your correspondent by assuring him that I have no theory of solar physics which I wish to prove by boiling stuff in a pan, he would be a bold man who would venture upon such a course. It is quite the "other way about," and even a peaceful domestic experiment may suggest lines of research, and point to conclusions to be reached by very different methods.—ARTHUR EAST.]

[It should be borne in mind that Mr. East's experiments are practically experiments upon the behaviour of convection currents under certain conditions. We have every reason to believe that convection currents play a primary part in the maintenance of the present condition of the sun, and in causing many of the phenomena which we observe upon it. To this extent Mr. East's experiments can teach us a good deal. By watching the behaviour of convection currents on a small scale, at feeble temperatures, and in a simple liquid, we can form a more vivid idea of the behaviour of convection currents on a cosmical scale, at transcendental temperatures, and in gases in which the most diverse elements are mixed or combined together in the most complicated manner. The experiments are most instructive when their necessary limitations are kept in view, nor does it seem to me that Mr. East has forgotten these.

I should like to add my accord with Mr. Buss's assumption, "that the causes of solar evolution are to be found on the sun itself." The eleven-year cycle is, to my view, essentially solar in its causes; not planetary, nor meteoritic. Yet I do think there is evidence of a slight modifying effect of planetary position on sun-spot behaviour; the spots do not, in my opinion, owe their formation to any planetary action; but their growth and decay may be affected to some degree.

[E. WALTER MAUNDER.]

THE NATURE OF SUN-SPOTS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—With reference to a long series of articles published in KNOWLEDGE about different observations of the sun, I wish to draw the attention of your readers to a question concerning the sun which, as far as I remember, has not been recently touched upon, *i.e.*, the nature of solar spots.

This was the subject of a communication which I made last year to our Russian Astronomical Society, in consequence of my having made observations of sun-spots for a series of years.

The observations of the spots show us without any doubt that they are *excavations in the Solar Photosphere*, produced by some yet unknown process. This is probably caused by and consists in enormous gas-eruptions, which after having torn through the photosphere of the sun rise up into the higher parts of its atmosphere and become apparent to us, as protuberances, if projected into the space, on the sun's border, and as faculæ, if projected on the sun's body.

There is certainly not the least doubt that the sun's temperature is rising from its surface to its centre, and that the layers below the photosphere become gradually the hotter the deeper they are placed. This consideration gives us the right to suppose that the sun's deeper layers, which we see through the openings of the spots, must be much hotter than the photosphere, and as such their immense temperature produces vibrations of the ether, of so great a rapidity and such minuteness of wave length that they are out of the range of sensibility of our optic nerves, and are therefore unable to affect our sight. The consequence of this is, that we see them black, because every ether-vibration of a very high range—such as the ultra-violet and the Röntgen-vibrations—are quite inappreciable by our eyes.

If this supposition be proved correct it will be of great value, and will not remain without its influence on our consideration of the whole universe surrounding us, and we shall have the right to put the question: Can we see all the heavenly bodies which surround us, or can there be some of so high temperature that they are black, because quite invisible to our eyes?

BARON N. KAULBARS.

Perki-Törwi, Villa Zewoshko, 5.

WIRELESS TELEGRAPHY AND HERTZIAN WAVES.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I am extremely pleased and flattered by the kindly critique of my little book, furnished by your reviewer in the September number of KNOWLEDGE. Precisely because the reviewer is so generally just I beg to point out that one or two inaccuracies have found a place in the critique, probably owing to hurried reading. In the first place, I say at p. 1, § 2, "Electricity appears to be a vibratory motion in the ultimate molecules of bodies," and not "an electrically charged body consists in rapid vibratory motions," as stated in your review. At p. 3 it is distinctly stated that "conductors offer little resistance to the passage of *electricity*"; but in no part of the book have I stated that non-conductors cannot enter into that vibratory motion which constitutes our electrified condition: on the contrary, at p. 10 it is clearly stated that the insulator lying between the excited body, and the induced, is primarily put into tho vibratory state, hence polarised, and capable therefore of setting up a like condition in the surrounding bodies, which if conductors cannot retain this strained condition, hence cannot transmit the inductive effect, unless themselves insulated. S. BOTTONE.

September 5th, 1900.

HIGH-SPEED TELEGRAPHY.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—No doubt once a paper ribbon is ready the high speed telegraph will work, but nothing is said of how a ribbon with its two rows of perforations is prepared. This operation must, I presume, occupy enormous time, and require a large amount of work.

BARON N. KAULBARS (Lt.-Gen.).

St. Petersburg.

[The perforating of the ribbons is done by a modified Wheatstone perforator, and the speed is the same as the speed of Wheatstone perforating. I have seen men prepare ribbons for the Wheatstone at a speed of 45 to 50 words per minute. If we say 25 words per minute we shall get a speed easily maintained for long periods.

One man can thus prepare 25 × 60—1500 words per hour. The Pollak-Virág apparatus, described in KNOWLEDGE for September, will send more than that number in one minute. So it would require over 60 men to prepare the ribbons to feed the apparatus. The same number of men would be required to transcribe the work at the receiving end. Thus we have 120 men fully occupied with the work of one wire. Suppose a speech of 6000 words were handed in to a telegraph office. It would under our postal system be cut up into pages of 100 words each. One page would be given to each of the 60 men who would prepare it in 4 minutes. The wire would be occupied not quite 4 minutes in sending it, and the 60 men at the receiving end would transcribe it in 4 minutes. Thus the whole would be received and in writing in less than 12 minutes, or allowing for delays, say in a quarter of an hour. This would be done with only one wire, a result impossible of achievement by any other system.

There is no possibility of getting the whole of the work done automatically, although the latest developments of the system (which have taken place since I wrote my article) promise a step even in that direction. The chief gain is the increased carrying capacity given to the expensive trunk lines, and the great usefulness when a breakdown or other circumstances limit the number of such lines.—C. H. Garland.]

ASTROLOGY.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—It is not my intention to enter into an argument concerning the truth, or falsity, of astrology with anyone who refuses to examine the subject for himself, but I wish to point out that I did not suggest that the five sense evidence should be left behind. Astrology is not a physical science, it is essentially meta-physical, and as such, it cannot appeal to the ordinary man of science who has not the intuition, the sixth sense, which is yet to be evolved by the majority.

If Mr. Maunder will change the word paganism into pantheism, he will be right in stating that astrology is a survival of the latter.

Alan Leo,
Editor of *Modern Astrology*.

9, Lyncroft Gardens,
West Hampstead, London, N.W.

[Mr. Chatley writes again at some length, but in view of Mr. Leo's letter, it seems unnecessary to do more than quote from his opening sentence:—"I am desirous of approaching astrology, not as a meta-physical abstraction, but as a material and mathematical science." If astrology were a physical science, there would be good cause for our enquiring into it, though Mr. Chatley is evidently a stranger to the methods and principles of physical research. But when after a history of some thousands of years we find its adherents differing on this fundamental point; the one declaring it is not a physical science but essentially meta-physical, the other, that it is not a meta-physical abstraction but a material and mathematical science, what conclusion can we come to but that it has no real basis at all? At any rate the astrologers must settle its standpoint amongst themselves first. If it be a physical science then we can apply physical and numerical tests to it. If not, it lies outside the scope of Knowledge, and we must decline further discussion upon it.

Whilst regretting the necessity of thus declining several lengthy communications that have reached us upon the subject, we would desire to acknowledge the courteous tone in which all our correspondents have written.—E. Walter Maunder.]

ANCIENT HINDU ASTROLOGY OR ASTRONOMY AND THE NINE PLANETS.

TO THE EDITORS OF KNOWLEDGE.

Sirs, The discovery of the planetary nature of Uranus and Neptune has, indeed, not been fortunate for the pretensions of astrology, nor yet for cheiromancy and metoposcopy, it is, however, fair to mention passages from Edward Upham's "History and Doctrine of Budhism . . . with Notices of the Bali or Planetary Incantations," 1829, pp. 87 and 94-5: "The Birmans mention eight planets, namely the Sun, the Moon, Mercury, Venus, Mars, Jupiter, Saturn, and another named Rahu, *which is invisible*" (italics mine). "The nine planets" in four astronomical works from the country of Dambadewa; expressly calculated for the Bali. Rahu and Kehettu are of the male sex, and *bad planets*. It is true that Upham thinks Rahu was an astrological sign rather than an anticipation of Herschel's discovery.

Charles G. Stuart-Menteath.

23, Upper Bedford Place, W.C.

[*Rahu* was not, strictly speaking, a planet, but was the mysterious body, the "dragon," or "dog," which occasioned an eclipse.—E. Walter Maunder.]

CLAY-STONES.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In digging a drain for my house, the workmen found three stones in the stiff clay; the largest about a foot in length, about as hard and heavy as iron. They are occasionally found, and are called "clay-stones" by the workmen. They appear to be of the nature of trap rock, and were with difficulty broken, in order to get them out. They were seven feet below the surface. How did they come into the clay? S. H. Wright.

3, Cator Road, Sydenham, S.E.

[I may refer Mr. Wright to Mr. H. Woodward's account of the London Clay, in his "Geology of England and Wales," 2nd edition, p. 436.

These concretions are common in the London clay and often include fossils. They result from the gradual accumulation of calcium carbonate or iron carbonate, or both, about some centre. Similar masses form the famous "black band" ironstones, worked for iron in our shaly coal-measures. The contrast of such nodules with the soft clay from which they have slowly concreted underground is commonly of a striking character.—G. A. J. Cole.]

LUNAR RAINBOW.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—A remarkably well-defined *lunar rainbow* was seen here on Wednesday evening, the 3rd of October. It was first observed by the writer about half past eight, and continued brightly visible till about ten o'clock, when it melted away in the surrounding darkness. The arc seemed from rough calculation to have a diameter about fifteen times that of the moon, and on its upper rim a bright star rested, forming an interesting feature of the phenomenon. From a point near this star a very brilliant blue coloured meteor darted away to the right of the observer in a south-westerly direction. The rainbow was cut off on the lower quadrant by a layer of black clouds. John Macintosh.

Strath Cottage, Galston.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

NUTCRACKER IN LINCOLNSHIRE.—Mr. F. M. Burton describes (see *Naturalist*, October, 1900, pp. 319-20) how he saw and heard a Nutcracker (*Nucifraga caryocatactes*), on August 14th, in a wood near Scotton Common, Lincolnshire. The Nutcracker is of very irregular occurrence in Great Britain. There are several forms of the Nutcracker. One inhabits Scandinavia, West Russia, East Prussia, and the Alps, and another inhabits Asiatic Siberia. It is the Eastern Siberian form that is the chief visitor to Western Europe. This bird periodically wanders westward in autumn, sometimes in large numbers. Such a migration has occurred this autumn in Scandinavia, where, for the last few months the Siberian form of the Nutcracker has been very common. The last "invasion" occurred, I believe, in 1887. The reason for these irregular migrations westward of this bird is considered by good authorities to be the failure in Siberia of the crop of pine-cones, the seeds of which are the Nutcracker's favourite food. Mr. Burton suggests that the bird he saw had bred here in England, but taking the above facts into consideration, this is most unlikely, and Mr. Burton's bird was most probably one of these wanderers from Siberia which are now visiting Norway and Sweden.—H. F. W.

The Greylags of Blair Drummond. By Lt.-Col. Duthie, M.B.O.U. (*Annals of Scottish Nat. Hist.*, October, 1900, pp. 193-6.) Under this title, Col. Duthie gives some interesting particulars of a flock of semi-domesticated Greylag Geese at Blair Drummond, in Perthshire. These birds have originated from a pair brought over from North Uist some twelve years ago. Since then they have reached a maximum of some fifty birds, but are now beginning to decrease. The reason for this seems to be a want of new blood. Although these birds behave much as wild ones, feeding cautiously in the stubbles, sometimes even in the same field as wild birds of their own species, and leaving their home lake in hard weather sometimes for as long as three months, they never associate with the wild birds, and neither go away with them nor bring a stranger back to their "home."

Red-crested Pochard in Yorkshire. (*The Naturalist*, October, 1900, p. 304.) A specimen of this somewhat rare duck is reported by Mr. T. H. Nelson as having been obtained at Redcar on January 20th, 1900. On the same page of the same journal, Mr. J. W. Fawcett reports that a specimen of the Red-crested Pochard was obtained at Redcar on February 10th, 1900. It may be that these two records both refer to the same specimen.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Notices of Books.

"AN ATLAS OF REPRESENTATIVE STELLAR SPECTRA." By Sir William Huggins, K.C.B., and Lady Huggins. (William Wesley & Son.) An observatory report in an edition de luxe is apt to strike one as something incongruous. And yet, in the book before us, we find the sumptuous form is truly fitted to the results therein expressed. The first volume of the publications of Sir William Huggins' Observatory is certainly unique in its appearance. It is not less so in its contents. It is a beautiful book, and its beauty is but an index of its scientific importance. Its chief purpose as its title implies is to supply an Atlas of Representative Stellar Spectra, so reproduced and arranged as to place the student as nearly as possible in the position of the original observers with respect to the light which those spectra can supply on the subject of Stellar life-history.

As this is the first volume of the publications of the observatory the earlier chapters naturally give an account of the history of the observatory, and descriptions of its instruments, chapter I. being in the main a reproduction of an article appearing in the "Nineteenth Century" for June, 1897. It is an account which, though written with much self-restraint, it is impossible for any scientific reader to peruse without a thrill of intensest interest. It is the story of the first explorer of unknown realms. "The time was indeed one of strained expectation and of scientific exaltation for the astronomer almost without parallel; for nearly every observation revealed a new fact, and nearly every night was red-lettered by some discovery." In all the history of the science there must have been few experiences indeed to parallel those which fell to Sir William Huggins' lot on August 29th, 1864, when he first turned the spectroscope on a planetary nebula, and again on May 18, 1866, when the Nova T Coronæ was first examined.

Chapter II. with its significant initial of the bee-hive with the motto "nil nisi labori" is simply a catalogue of papers published on the work done in the observatory. These are over eighty in number, and almost every one was the breaking up of new ground.

The three following chapters are concerned with the description of observational and instrumental details, and chapter VII. contains a description of Plate II., which is devoted to fifteen "historical Spectra"; some of the most interesting pioneer photographs obtained at the Tulse Hill observatory. The chief importance of the book, however, rests in Plates III. to XII., and chapters VI. and VIII., the latter being the detailed description of the plates, with a preliminary discussion of them. Of these Plates XI. and XII. are of quite exceptional importance, containing as they do the separate spectra of the components of six double stars, the beginning of an entirely new subdivision of stellar spectroscopy and one which promises specially important results.

Chapter VI. gives a "discussion of the evolutional order of the stars," and is the principal portion of the text. Next to the great problem of the structure of the heavens, which Sir William Herschel attacked with such Titanic energy, ranks this question of stellar evolution; indeed the two are intimately connected. Ever since the spectroscope enabled us to differentiate between the radiations of star and star it has been under discussion, and especially so within the last decade. Sir William Huggins's treatment of it is characteristic in its clearness, caution, and restraint, and brings out some new points of great importance. Proceeding from the definition that "in a classification of stars, that type of star must come first which we have reason to believe to be the most diffuse, or in other words in the stage in which condensation is least advanced," he insists strongly on the almost forgotten or neglected influence which the change of surface gravitation would exert as condensation proceeded. Adopting Lane's results, Sir William gives great prominence to the fact that the temperature of a star must increase with its condensation, so long as it is purely gaseous. The "youngest," i.e., the least condensed stars, though the richest in potential energy, are therefore not the hottest. In connection with this point he gives the deduction from his own stellar photographs that the "solar" or "metallic" stars,—obviously more condensed than the "hydrogen" or "white" stars—yet have their continuous spectra between the absorption lines relatively more brilliant in the ultra violet. This is a point of the first importance and is an obvious challenge to the extremely detailed scheme of stellar temperatures recently published by Sir Norman Lockyer. The statement will no doubt be carefully examined by other competent workers, but in the meantime the extreme care, patience and caution which always characterize Sir William and Lady Huggins' work, and the nature of their equipment, enabling them to secure spectra well defined as far as wave-length 3300, give it a commanding weight.

The quantity of work which Sir William and Lady Huggins have accomplished is remarkable, but its quality is more striking still. Their researches on the spectrum on the great nebula in Andromeda afford perhaps the best illustration of the tireless patience and delicate skill with which they have followed up an object of so much difficulty.

The present volume though so important is evidently not intended by its authors to stand as a complete setting forth of their work. It is Volume I., and all astronomers will look with eager anticipation for Volume II., which we would hope may contain the authors' researches on the Wolf Rayet Stars, the study of which they have followed with such conspicuous thoroughness.

"INTRODUCTION TO ZOOLOGY. A Guide to the Study of Animals, for the use of Secondary Schools." By C. B. and G. C. Davenport. (The Macmillan Company.) Illustrated. Price 6s. Unlike many works in popular natural history, in this excellent little volume the greater portion of the text is devoted to the invertebrates, the vertebrates receiving only that amount of space to which they are entitled by "proportionate representation." The contents of the second chapter taken at haphazard, which treats of the butterfly and its allies, will serve as an example of the method followed in other groups. Firstly, we have the systematic position and characteristics of these insects concisely but adequately explained. This is followed by an account of their habits, which is in turn succeeded by a discourse on the different sexual features and the phenomenon of polymorphism. Next we find a capital dissertation on mimicry and protective resemblances, followed by a brief account of the different families of butterflies and moths. This naturally leads on to the consideration of the other great order of four winged insects—the Hymenoptera—and the chapter closes with a cleverly drawn-up "key" to the identification of the various families of the two orders in question. Where we have tested these "keys," as we have done in the case of the vertebrates, we find them in the main very satisfactory, although we must protest against the definition "without hands" which is used in the case of the carnivora and rodents, for surely the fore-paws of a squirrel subserve almost all the uses of those appendages. The style in which the work is written is as attractive as the brevity of treatment admits, and we are glad to note that economic zoology comes in for a fair share of attention. Neither are extinct forms altogether omitted, mention being made, as occasion requires, of some of the more important groups. It scarcely, however, gives a true conception of the fact to allude to the various orders of extinct reptiles as if they were merely families of the Lacertilia. All the illustrations are good, and many of them excellent: the reproductions from photographs of living fish by Dr. Shufeldt being a new feature worthy the best attention of all naturalists. The artistic grouping of animals in fac-similes of their natural environment, as in the case of the black Alaskan sheep, is also to be commended. When it is added that laboratory work forms an important item in the contents of this admirable little volume, we think we have said enough to commend it to the best attention of our readers, whether juvenile or otherwise.

"THE LETTERS OF JÖNS JAKOB BERZELIUS AND CHRISTIAN FRIEDRICH SCHÖNBEIN, 1836-1847." Edited by Georg W. A. Kahlbaum. Translated by F. V. Darbishire and N. V. Sidgwick. (Williams and Norgate. 3s. We have already called attention this year to the letters of Faraday and Schönbein, which were published under the same able editorship as those now before us. Schönbein, as early as 1827, had spoken of Berzelius as one of the leading lights of the age among chemists. He had, indeed, made unsuccessful efforts with London publishers to arrange to translate Berzelius' *Lärbok i Kemien* into English, a disappointment which prevented Schönbein, as he said, not only from benefiting British chemists, but also from raising sufficient money to take him to Stockholm to conclude his studies under "the consummate master of chemical science." In 1828, Schönbein was appointed to his professorship at Bâle, from which place eight years later he began his correspondence with Berzelius. The first of the fourteen letters of Schönbein's included in this volume was despatched from Bâle on the 22nd April, 1836, and contains an account of his experiments on the action of nitric acid on iron; but no answer was received from Berzelius until 4th May, 1837, when he wrote giving his views on the "passive" state of iron, and expressing the hope that the search would be continued. Schönbein's last letter to Stockholm is dated 29th March, 1847, so that intervals of about twelve months elapsed between the different letters. The characteristics to which we directed attention when dealing with the correspondence of the Bâle professor with Faraday are here also very noticeable. Schönbein was always anxious to obtain the opinions of contemporary men of science upon the conclusions he drew from his researches, and ever willing, if he saw sufficient reason, to modify his views. There is, however, an absence of those expressions of cordial friendliness which were so marked and pleasing an accompaniment to the strictly professional interest of the letters which passed between Schönbein and Faraday. But, tracing as they do, the steps which led to the discovery and isolation of ozone, the letters before us are sure to prove of great interest to students of chemistry.

"PAPERS ON MECHANICAL AND PHYSICAL SUBJECTS." By Osborne Reynolds, F.R.S., MEM.INST.C.E., LL.D. Volume I. 1869-1882. (Cambridge University Press.) 15s. net. Professor Reynolds has availed himself of the liberality of the Syndics of the Cambridge University Press, and has had the papers contributed by him to the *Transactions* of various learned societies and other journals reprinted in a collected form. The present volume is the first of two, and contains the work of the years 1869-1882; the remaining part, which is not yet ready, will include papers down to the present year. The chronological order of the essays reveals an interesting peculiarity in the work of most men of science. There is but little continuity in the subjects dealt with year by year. One piece of work sometimes leads to a second of a completely different character, and much time may elapse before the original research is carried forward toward completion. To obviate this difficulty the student consulting the book is provided with two sets of references. When reading earlier papers he is referred forward to succeeding pages on the subject, and in studying later papers there are back references given. It will serve to give some idea of the range of subjects included in Professor Reynolds's researches when it is said that the present volume includes, among many others, papers treating of the tails of comets, the phenomena of thunderstorms, the action of rain to calm the sea, the steering of screw steamers, and the bursting of guns. The steering of ships has been a favourite investigation with Professor Reynolds. Papers 13, 19, 21, 26, 28, 32, and 37 are all concerned with different phases of the all important question. A second extensive research worked at during these years was that on the dimensional properties of matter in the gaseous state, the account here given of this work runs to 130 large pages. We hope this handsome book will be added to the library of every college where mechanics and physics are taught, and to the reference department of all large libraries. It is but rarely that a professor of engineering makes such valuable additions to scientific knowledge outside his own department as are contained in the papers in the present volume.

"ELECTRIC LIGHTING." By A. C. Swinton. (London: Crosby Lockwood & Son.) 4th Edition. Illustrated. 1s. 6d. That this little book should have attained its fourth edition is to some extent remarkable, for (since it only deals in generalisations concerning the elements of the subject) one might be pardoned for thinking that the public appealed to had been already more than satisfied. However, so far as the work before us goes, it has the very solid merit of being accurate, technically, though there are some passages wherein looseness of expression is to be found. For example, at p. 15, one may read: "A standard candle is the amount of light derived from a candle . . . . etc." Now, clearly, if candles can be derived from the burning of candles, there is very little sense in the burning of any other fuel!! But this, in itself, is a trivial matter, though, unfortunately, such verbal slips meet us more than once. Still, be all this as it may, technically the work is accurate, yet, as already suggested, it does not go far. We find, for instance, "Motor generators" discussed and dismissed in the space of those eight lines which come last! We would suggest both an enlargement and an editor.

"A TEXT-BOOK OF ZOOLOGY, TREATED FROM A BIOLOGICAL STANDPOINT." By Dr. O. Schmeil. Translated by R. Rosenstock, and edited by J. T. Cunningham. Parts I. and II. (A. & C. Black.) Illustrated. The dominant idea in this book is the structural adaptation of animals to their inanimate surroundings; and therefore, instead of being a series of dry descriptions of details of anatomy, form, and colouring, it treats of animals as living machines suited to perform particular kinds of work. At least this is stated by the editor to have been the aim of the author; and, on the whole, the intention has been fairly well carried out. The work is intended for schools and colleges; and if young students become imbued with its spirit, they will be in a fair way to gain a practical acquaintance with natural history from its best and most attractive side.

Of the two parts before us, the first deals with mammals, while the second is devoted to birds, reptiles (including amphibians), and fishes. A third part will complete the work, which is published at the very low price of 5s. 6d. per part. The mode of treatment is to take a certain number of typical animals, and to draw attention chiefly to those structural peculiarities specially connected with its mode of life; notes on its relatives being added as occasion seems to require.

To an English reader the work suffers to a certain extent from having been "made in Germany." Not only is this apparent in the cast of thought, but frequently in the selection of species as familiar examples which although common on the Continent are unknown in the wild state in Britain. As an example of this treatment from a German point of view, we may quote the concluding sentence from the account of the fox, which runs as follows:—"The sportsman, however, pursues it incessantly, and regards its fur as a small repayment for the many depredations it commits among the game." Surely it was within the province of the editor to excise or modify such a very un-English statement. But, quite apart from certain minor mis-statements of fact, there are points where, in our opinion, editorial supervision is conspicuous by its absence. For example, the author has omitted all mention of such important groups as the Sirenians among mammals, and the Rhynchocephalian lizard among reptiles, while the classification adopted for the birds is hopelessly antiquated and discredited. The illustrations, which are numerous, are by no means of equal merit, a few being excellent, while for others scarcely any words of condemnation are adequate. Being apparently culled from several sources, they do not by any means indicate the relative sizes of the animals depicted: the badger, for example, being drawn of considerably larger size than the Indian rhinoceros. On the whole, while there is undoubtedly much to commend, we think that the publishers would have been better advised had they made arrangements with a competent English naturalist to write an entirely new work.

"ORIGIN AND CHARACTER OF THE BRITISH PEOPLE." By Nottidge C. Macnamara. Smith, Elder & Co. 6s. The most casual observer cannot but have been impressed by the pronounced differences in the types of men found in different parts of the British Isles. The characteristic Welshman is manifestly a different kind of man from the average Englishman, and nobody would mistake a native from south-west Ireland for a lowland Scotchman. The object of Mr. Macnamara's little book is to account for these differences, and to trace their causes. He believes that the present peoples of Great Britain are derived from an original Iberian stock, or to use his own words "the Iberians formed the primary stock from which the existing inhabitants of Great Britain, and the West of Europe are derived . . . . . it was this race, and only this race, who inhabited our islands at the close of the palæolithic period." These Iberians were a short, small-boned people, having long skulls and comely features. The next addition to the inhabitants of our islands was from Western Asia, in the early neolithic period, of a branch of the old Aryan race. These tall strangers were an energetic war-like people, who formed the Cro-Magnon race. Then came the dolman-building people. After tracing in this way the origin of the peoples of the British Isles the author takes the constituent countries in succession, beginning with England, and discusses the racial effects of immigrations which have occurred in historical times. He concludes with a consideration of the development of man's intellectual faculties and the effect of residence in cities on the racial qualities of individuals. The book contains thirty-three illustrations, and provides a clear account of a very interesting subject.

"ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM." By S. P. Thompson, F.R.S., etc. Macmillan. Illustrated. 4s. 6d. The bibliographical note attached to this work will doubtless exercise much influence, running back as it does to the year 1881, and mentioning no less than three reprints in many of the years which have elapsed since that date. The preface, too, is well worth attention, and we note that Professor Thompson takes an early opportunity of complaining of "The piracy, covert as well as open, to which, since its appearance in 1881, the book has been subjected." In this section of the work we find, too, an accurately terse synopsis of the progress made in matters electrical and magnetic during the past thirty years. The first chapter deals with frictional electricity, and here we are bound to say that we can find nothing new, while many of the illustrations and diagrams are antique. In Chapter 2, Section 154—on magnetic maps—strikes us as being the most useful; while Section 159—magnetic storms—is disappointing. A detailed description of all well-known primary batteries follows. This portion of the book, by the way, contains a statement of Ohm's law, an interpolation which seems quaint. The latter part of Chapter 3, dealing with "Physical and Physiological Effects of the Current," may be highly commended (even to the notice of students of a larger growth, though the book is termed "Elementary"), for it is not, we believe, many who could define such terms as "electric osmose." The collection of notes upon the electrical properties of flame and hot air is interesting, as also those relating to thunderstorms and similar phenomena. On pp. 354-5 we note that the definition of permeability is somewhat lengthy. Indeed, it takes our author some time to explain $\mu = \frac{B}{H}$. Finally (since this work deals very thoroughly with the elements of electricity and magnetism), it follows that it contains much which has been written again and again. The problems and exercises with which the work concludes are particularly comprehensive, and should be helpful alike to teacher and pupil. The index, too, is good.

"THE STORY OF BIRD-LIFE." By W. P. Pycraft. Newnes' Library of Useful Stories. Illustrated. 1s. Mr. Pycraft is to be congratulated on having compressed into the very small compass of this little book a very fair general notion of the main features of bird-life. Considerable discrimination is shown in the selection of material, the author having chosen good subjects, and interesting and, for the most part, well-established facts. Moreover, Mr. Pycraft writes in a simple and attractive way, so that the book is very readable and interesting, and contains a deal of instruction in an unobtrusive form.

"IN BIRD-LAND WITH FIELD-GLASS AND CAMERA." By Oliver G. Pike. (Fisher Unwin.) 6s. Illustrated. This is a pleasant little book describing simple country sights within the province of all who have learnt to use their eyes. The author treats chiefly of birds, and his scenes and anecdotes are mostly derived from the country about the north of London, although a few chapters are devoted to the Norfolk Broads. Mr. Pike is an ardent bird photographer, and many of his photographs reproduced in the book are excellent. Some of them, however, are rather in the nature of puzzle pictures, and it is questionable if everyone will eventually find the bird. Photographs of wild birds or nests are certainly of little use for purposes of identification, but a method of showing at a glance the correct proportions would be a distinct gain. Turn, for instance, to the photographs on pages 245 and 265 of the present book. The one is of a sedge warbler's nest, the other of a nest of Montague's harrier, but who can tell by an examination of these photographs that the egg of the harrier is some two-and-a-half times the size of that of the sedge warbler? On the other hand, in the beautiful photograph, forming the frontispiece to the volume, of a garden warbler on its nest, we get a very good idea of the relative size of the bird. This is evidently because some gooseberry leaves are shown in line with the bird, and everyone knows approximately the size of a gooseberry leaf, and so can gauge the size of the bird. But it is not often possible in a photograph from life to show side by side with the bird or egg so well known an object as a gooseberry leaf. However, with so many enthusiasts now working at bird photography, we do not despair of a solution to this difficulty of proportions. Mr. Pike's grammar is not always of the best, and his rather bald literary style denotes a young writer, but he leads us in the open, and evidently tells us exactly what he has seen himself; which, after all, is more valuable in a book of this character than flowing phrases and polished periods. The author was fortunate in finding in Norfolk a number of bearded tits to shoot at with his camera, and we are glad indeed to have this further evidence of the presence of this rare bird in the country. Ornithologists will also be interested in what Mr. Pike has to say about the habits of the moorhen.

BOOKS RECEIVED.

The Riddle of the Universe. By Ernst Haeckel. (Watts & Co.) 6s. net.

The Royal Observatory, Greenwich: Its History and Work. By E. Walter Maunder, F.R.A.S. (Religious Tract Society.) Illustrated. 5s.

The Bible Atlas. 6th Edition. By Major-General Sir C. W. Wilson. (S.P.C.K.) 10s. 6d.

Inorganic Chemistry. By Prof. Meldola. 5th Edition. (Murby.) 2s.

A German Commercial Reader. By S. E. Bally. (Methuen.) 2s.

Design in Nature's Story. By Walter Kidd. (Nisbet.) 3s. 6d.

Elements of Hydrostatics. By S. L. Loney, M.A. (Camb. Univ. Press.) 4s. 6d.

Religion and Life. By R. Russell. (Longmans.) 2s. 6d. net.

The Origin of Species. (Popular Edition). By Charles Darwin. (Murray.) 2s. 6d. net.

The Temples and Ritual of Asklepios. By Richard Caton. (Camb. Univ. Press.) 3s. net.

Astral Gravitation. By Wm. Leighton Jordan. (Longmans.) 9s.

Annals of the Lowell Observatory. Vol. II. (Camb. Univ. Press.)

The Reliquary and Illustrated Archaeologist. Vol. for 1900. (Bemrose.) 12s. net.

Agricultural Zoology. By Dr. Ritzema Bos. (Methuen.) 3s. 6d.

Elements of Geology—Skertchly's. Revised by James Monckman. (Murby.) 1s. 6d.

Animated Picture Specialities. Catalogue. (Warwick Trading Co.)

Elements of Mineralogy. By F. Rutley. (Murby.) 2s.

One Thousand Objects for the Microscope. By M. C. Cooke. (Warne.) Illustrated. 2s. 6d.

An Ingenious Method of French Conjugations. Parts I., II., III. By Leopold Courtial. (Firth College, Sheffield.) 1s. 6d. each.

Masterpiece Portfolios of Art. No. 3. (*Review of Reviews* Office.) 1s. 3d. post free.

THE PYGMIES OF THE GREAT FOREST.

By R. Lydekker.

In the preceding article of the present series the attention of the reader was directed to the dwarf black races of the tropical forests of Luzon and the coral shores of the Andamans. He has now to transport himself in imagination to the great forest of the Upper Congo and the watershed between the basin of that mighty river and the Nile in the Niam-Niam country. So vast is this forest, as we learn from the accounts of Sir H. M. Stanley and other explorers, that the traveller may march through it for weeks or even months without finding a break in the wilderness of stems, while so dense is the canopy of branches and leaves overhead that even at midday, when the sun is shining in its full strength above, the light is toned down to a grey gloom, and the shades of night fall long before the sun has touched the horizon. In this perpetual gloom live the Pygmies, the most diminutive of the human inhabitants of the globe, of whose existence there have been more or less authentic rumours since the time of Herodotus and Aristotle, but whose true characteristics and mode of life it has been reserved for recent times to disclose. To the ancient Egyptians the Pygmies were well known, under the name of Danga, and there are definite records of individuals being from time to time brought from the region of the White Nile to the court of the Pharaohs as captives, where they were depicted in the frescoes under the name of Akka. The accounts given by the ancient classical writers of these diminutive people, which were not improbably derived from the Egyptian captives, are, however, so vague and so mingled with the fabulous that they are of little or no value to the anthropologist. But in the early part of the seventeenth century the English sailor, Andrew Battell, who had been in captivity among the Portuguese from 1589 to 1607, gave an excellent although brief account of the Pygmies, whom he calls Matimbas, and compares in point of size to European children of twelve. He speaks of them as fleeing from contact with the Negroes of Loango, and slaying with their bows and arrows (which were carried by both sexes) the great apes called Pongo; the latter term being, by the way, the proper name of the species we now designate gorilla. Again, in 1686, the Dutch writer Dapper speaks of the dwarfs of the same district under the names of Mimos and Bakke-bakke; but from that date nothing seems to have been heard of these people till the sixties and seventies of the present century.

In 1861 Dr. Touchard records the destruction of a tribe of dwarfs, whom he calls Akoa, in the interior of the Gabun; and states that an adult who had been captured measured only 4½ feet in height, and had a comparatively short and rounded head. Yet another tribe inhabiting the interior of the Gabun, known as the M'Boulous, were described about the same date, and stated to be not more than three thousand in number. Somewhat later the Babonkos, or Pygmies of Chinchoxo, were described by a German writer, who comments on their relatively large and rounded heads and small stature; a man supposed to be about forty years of age measuring rather less than 4 feet 6 inches. Paul du Chaillu likewise encountered Pygmy Negroes in Ashangoland, and saw one man of the stature just mentioned, although he gives the average height of the women at 4 feet 8 inches.

In still more modern times, when the interior of the Dark Continent was being gradually opened up, Stanley heard of Pygmies, whom he calls Watwas, in the country within the great bend of the Congo, who hunted the lordly elephant to death with poisoned arrows, and whom he describes as of a chocolate-brown colour. And a Dr. Wolff refers to the members of the same or an allied tribe as never exceeding 4 feet 7 inches, and averaging four inches less in height. But to the celebrated German traveller, Dr. Schweinfurth, was reserved the honour of first making known to European science the Akkas of the ancient Egyptians, whom he first met with at the court of the ruler of Mambettu (Monbuttu), but whose home is on the Aruwimi, a tributary of the Upper Congo in about lat. 3° N. and long. 25° E. As we learn from Major Casati's "Ten Years in Equatoria," the author of which accompanied Stanley in his famous expedition to relieve Emin Pasha, the name Akka means pigmy or dwarf; being also applied by the natives of the Aruwimi country to a breed of diminutive fowls. By themselves the Akka are called Efé. Akka is their Mambettu name, while in Sandeh they are termed Tiki-tiki. The latter name, according to the traveller last mentioned, is, however, occasionally heard in Mambettu, and is not, as has been supposed, synonomous with Akka. Properly speaking, says Major Casati, Akka is applicable to one very small active race, whose skin is of a reddish brown colour and thickly covered with hair, while Tiki-tiki denotes a taller and stouter-built race, with a darker and less hairy skin who frequent the more open mountainous regions. The two are said to be unfriendly and frequently at war with each other. The Akkas seen by Dr. Schweinfurth were in the military service of the ruler of Mambettu; one of them, who unfortunately died at the end of the journey down country, was procured for the purpose of being taken to Europe. More fortunate in this respect was the Italian traveller Miani, who, although himself falling a victim to the climate and the hardships of travel, was the means of procuring two Akkas, who arrived safely, first at Cairo, and subsequently in Italy; one of them dying at Verona in the winter of 1883. An Akka girl was also brought by another Italian traveller to Trieste. Later Emin Pasha transmitted to the Natural History Branch of the British Museum the skeletons of a male and female Akka; the latter, which Major Casati says was obtained by himself and presented to Emin, being nearly complete, and now mounted in the exhibition series. Making due allowance for a few missing vertebræ, and likewise for the soft tissues, this

An Akka Woman. (From Major Casati's "Ten Years in Equatoria." Warne & Co.)

skeleton, in the opinion of the late Sir W. H. Flower, indicates a woman of exactly four feet in height, who was evidently fully adult. Emin states, however, that a living woman whom he measured barely reached 3 feet 10 inches; being therefore greatly inferior in point of size both to the Pygmies of Asia and also to the Bushmen of South Africa. Nevertheless, as may be seen in the aforesaid skeleton, and also in the numerous portraits of these little people which have been published of late years, the Negrillos (as the African Pygmies are technically called) are in all respects well formed and well proportioned.

Descriptions of the Akkas and other tribes of Pygmies have also been published by Major Casati, as well as by several other later African travellers; and we now possess a very large amount of information not only with regard to their physical characteristics and their mode of life, but also in respect to their geographical distribution. It is now ascertained, for instance, that the range of these dwarfs originally extended from near the Atlantic sea-board in the Gabun district as far eastwards as the confines of Lake Tanganyika; and from N. latitude 3° on the Aruwimi river to about latitude 7° in the neighbourhood of Lakes Stephanie and Rudolf, where they were recently encountered by the American traveller Dr. Donaldson Smith. In the Lake Rudolf district, where they are known by the name of Dume, these people depart, however, so widely from the diminutive stature of the Akkas of the Aruwimi that they can scarcely be called Pygmies at all in the literal sense of that term; Dr. Donaldson Smith giving their average height as about 4 feet 11 inches. Nevertheless, as this tribe seems to agree with the more typical Pygmies in general physical character, its members must be included among the Negrillos. Not improbably their superior stature may be attributed to climatic influences, and perhaps also in some degree to crossing with the Negro tribes among whom they dwell. That such crossings do take place seems to be evidenced by certain tribes living on the upper Ituri, who are believed to trace their origin to inter-breeding between pure-blooded Negrillos on the one hand and Bantu or other negroes on the other.

Exclusive of these aberrant frontier tribes, Sir William Flower estimated the average height of the African Pygmies at about 4 feet 7 inches for the men, and 4 feet 3 inches for the women; this estimate according fairly well with that of Major Casati, who says that most Akkas do not exceed 4½ feet. As has been already stated, in the rounded and broad form of their heads, these people differ markedly from the long-headed Negroes among whom they dwell; although this character is not so pronounced as was at first considered to be the case by some observers. Chocolate-brown has been mentioned above as the colour of the skin of the Pygmies, and it has been compared to ordinary tablet chocolate or to slightly roasted coffee-berries. In this respect, therefore, these people differ markedly from their southern cousins the Bushmen, in which it is leather-yellow. Moreover these people lack the prominent cheek-bones and lozenge-shaped face of the last-mentioned race; while the women seldom exhibit in any marked degree a peculiarity of figure characteristic of the "Hottentot Venus" and other Bushmen females. Then, again, although the scalp-hair in all these African races is of the frizzly, or mis-called woolly, type, that of a Pygmy does not grow in tufts like the black locks of a Bushman, but is described as being of a more fleece-like character, and is frequently of a more or less light shade of brown. But the most remarkable capillary peculiarity of the Akkas is the presence of a fine down over the whole skin; Emin Pasha stating that in the individuals examined by him this took the form of thick, stiff hair, almost like felt; this hair, according to the observations of Major Casati already referred to, being more developed in the typical Akkas than in the Tiki-tiki. Adult men have a certain amount of hair on the cheeks and chin. In connection with the down on the body, it may be mentioned that a very similar hairy covering is found on the children of the higher races of mankind some time previous to birth. As regards their general cast of features, Akkas display a somewhat ultra development of the ordinary Negro type, this being specially marked in the projection of the jaws, the eversion of the lips, and the width and flatness of the nose. In a convexity of the profile below the nose Akkas display a character often met with among Bushmen.

From the various accounts that have been given of their mode of life, it appears that Akkas, like other African races of Pygmies, live chiefly by the chase, using bows, arrows, and lances with great dexterity, and slaying such large animals as elephants, buffaloes, and chimpanzees with comparative ease. On account of this dexterity in the use of weapons, as well as from their skill in hunting, their great bodily activity, and their personal courage, they are much esteemed as soldiers by the Negro tribes among whom they dwell, and whom they frequently serve as mercenaries. In other respects they appear, however, to avoid their neighbours, living in communities by themselves in tribal divisions, each of which has its own chief or king. No protection against cold being necessary in the tropical climate of equatorial Africa, most of them go about completely naked, those men who wear any covering at all being generally content with a piece of beaten bark suspended round the waist, while the women have only two or three leaves. No ornaments of any kind are worn by the former, while the latter do not pierce their ears. Although they are superior to the Australians in being acquainted with the mode of obtaining fire, yet they are by no means skilful in this operation, and they are accordingly in the habit of keeping trunks of fallen timber smouldering in certain suitable situations to which the members of the tribe can repair when they require a light. Each family manages its own affairs, and wives are purchased from their fathers for the consideration of a certain number of arrows. Unlike Negroes, these people are entirely free from superstitions of every kind, so that there are no witch doctors nor sorcerers among them; even the widely spread dread of the "evil eye" being, according to Major Casati, unknown among them. Judging from the circumstance that they bury their dead on the spot where they expire, without any ceremony and with no monument, it would seem, too, that they have little if any conception of a future existence or of a divine ruler of the world.

Many of the Akkas live entirely without shelter, save such as is afforded by the forest thickets or the overhanging banks of streams. Others, however, erect hemispherical huts, thatched with broad leaves, and having a diameter of about 6½, with a height in the centre of somewhat less than 5 feet. Generally these primitive erections are scattered about at random in the forest or on the hills, although in rare instances they are aggregated into villages. These people are in the habit of exchanging the products of the chase with their Negro neighbours for arrows and lances, but use no other implements, a sharp arrow fulfilling the purpose of a knife; they possess no vessels of any description, drinking water from the streams in the hollow of the hand. Although they will eat almost any animal substance, inclusive of locusts and white ants, they have the saving virtue that they are not cannibals; and they never use salt. Neither do they keep poultry or other domesticated animals; and the arts of agriculture and horticulture are unknown among them. After a successful hunt, they are stated by Major Casati (from whose account we are largely quoting) to visit the banana plantations of their neighbours, where for every bunch of fruit that they sell a piece of meat is substituted. When, however, they have nothing to offer by way of exchange, they are not above acquiring a bunch of bananas by the simple expedient of stealing it; and they not unfrequently make raids upon their taller but less warlike neighbours for the purpose of carrying off these and such other vegetable products as they can lay hands upon. They are, indeed, passionately fond of vegetable food, of which they will devour almost incredible quantities when opportunity occurs, being at all times endowed with a marvellous capacity for food.

In addition to their bows, arrows, and small lances, in the use of which they display remarkable skill, the Akkas carry small shields, of about 20 inches in length by 12 in width, which they manufacture themselves by plaiting strips of bark. In elephant and buffalo hunting they resort to the cruel method of first blinding the unfortunate animal with arrows and then harrying it to death with their lances. The use of nooses and nets, either on land or in the water is quite unknown among these primitive little people, who are likewise unacquainted with angling. Consequently, their only method of capturing fish is by damming off some portion of a stream or pool, and then laboriously baling out the water until its denizens are left in the mud.

Turning to the consideration of the affinities of the Akkas and their kin, we are confronted with a problem of great difficulty, and one to which our present means of information do not admit of giving a decisive solution. It has been suggested by a Swiss anthropologist that certain prehistoric human remains discovered at Schaffhausen indicate the occurrence of Negrillo Pygmies in Europe; but this hypothesis, to say the least, seems to stand in need of confirmation. Putting this aside, almost the only safe statement that can be made is that Negrillos form a branch of the great Negroid stock. Before their characteristics were as well known as at present (and there is still room for much advance in this respect) they were considered to be near allies of the Bushmen; but, as Dr. Deniker well observes, there is little or no foundation for this idea, as there are few features common to the two races, while the dissimilarities are many and strongly marked. Neither have we any decisive evidence of a close relationship between the Pygmies of Asia on the one hand and those of Africa on the other, although both are included by Mr. A. H. Keane under the title of Negrito.

But the whole question of the origin and relationships of the Negroid stock is still involved in such a maze of confusion and uncertainty that it is very difficult to find even a single firm starting point upon which to base further inductions. According, however, to the best of authorities, it seems probable that the Bushmen indicate the most primitive and generalised representatives of this stock with which we are acquainted. And if this be so, it follows that the black skin of the true Negroes and of the Pygmies is an acquired and not a primitive feature; support to this theory being afforded by the fact that Negro infants are much lighter coloured than their parents. Possibly then, both Bantu Negroes and the Akka Pygmies are diverging branches from a stock related to the modern Bushmen. But whether we are to look upon the Asiatic Pygmies as more closely allied to the Akkas than to any other Negro races may for the present be left an open question.

It may be added that if the light-coloured Bushmen be really the most primitive type of the Negroid stock, a death blow is delivered to the theory of a specially near relationship between the latter and the black-skinned Anthropoid Apes of Equatorial Africa.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

It frequently happens that the objects for which the microscopist is searching are mixed with coarser materials, from which it is necessary to separate them. As a rule judicious washing will effect the purpose, but sometimes it is necessary to resort to burning or to the action of chemical reagents. Guano and various organic matters are cases in point which yield interesting residues after everything soluble has been washed away, and everything combustible has been burnt either with fire or with nitric acid. The siliceous cuticles of plants, too, may be procured by destroying all the other parts by chemical means. An effective way is to heat the specimens in nitric acid, and add slowly and very cautiously a small quantity of powdered chlorate of potash. This operation needs great care, and the face and hands should be protected from the spluttering of the boiling acid.

Considerable confusion exists as to the proper nomenclature of photography with the microscope. In Germany and France the term micro-photography is very common, while in English photo-micrography and micro-photography mean very different things. Thus: a *photo-micrograph* is a photograph of a small or microscopic object, usually made with a microscope and of sufficient size for observation with the unaided eye; while a *micro-photograph* is a small or microscopic photograph of an object, usually a large object, like a man or a building, and is designed to be looked at with a microscope.

Collodion stained with aurantia makes a useful colour screen. Dr. Leaming, when preparing the negatives for the plates of Wilson and Starr's atlases, made his colour screens by staining a lantern plate, from which all the silver salts had been removed, with an alcoholic solution of tropaeolin, and then, after drying, Canada balsam and a cover-glass were applied.

When a carmine stain is to be used the results may be obtained quicker by heating the stain. Place the watch-glass containing the stain on a wire netting over the opening of a water bath. As the water boils the heat of the steam will cause the stain to penetrate more rapidly, with the result that the details of the specimen are brought out more sharply. These results may be obtained only with tissue which has been previously hardened. Those hardened in a solution of chromate of potash to which a few drops of chromic acid have been added give the best results.

Of the many mounting mediums miscible in water which are used by the microscopist the most generally useful is glycerine. It is necessary that it should be pure, and to be quite sure that all foreign matters such as dust particles are eliminated, it should be filtered through filter paper or absorbent cotton before being used. For preparing objects for final mounting, glycerine and water mixed in equal quantities forms a good mixture. For many purposes the final mounting in glycerine is made in an acid medium, viz., glycerine 99 c.c., glacial acetic acid 1 c.c. By extreme care in mounting, and by occasionally adding a fresh coat to the sealing of the cover-glass, glycerine preparations last a long time. They are liable to be very disappointing, however. In mounting in glycerine care should be taken to avoid air-bubbles, as they are difficult to get rid of. A specimen need not be discarded, however, unless the air-bubbles are large and numerous.

We have pleasure in calling the attention of microscopical societies to the list of lectures which has been arranged for delivery by members of the Extension section of the Manchester Microscopical Society during the coming winter. The lectures and demonstrations treat of every phase of microscopy, and are given gratuitously to any society that may care to apply for them. Applications may be made to the Hon. Secretary, 56, Brookland Street, Eccles New Road, Manchester.

Ink for writing on glass may be prepared by dissolving 20 grams of brown shellac in 150 c.c. of alcohol in the cold, then adding, a drop at a time, a solution consisting of 35 grams of borax dissolved in 250 c.c. of distilled water. If this precipitates the shellac add more alcohol, allowing the excess to evaporate afterwards, or warm the solution until the precipitate disappears. One gramme of methylene blue may be used to colour the ink.

The following easy and efficient method of preparing nucleated blood for class use has been adopted in the histological laboratory at Cornell University. A few drops of the fresh blood of a necturus are put in a solution of osmic acid (1 per cent.) and allowed to stand for fifteen minutes. The corpuscles by this time are fixed and have settled to the bottom, and the fixer can now be decanted off. After washing in water the blood is carried on through the various grades of alcohol, stained with paracarmine, dehydrated, cleared, and, as a final step, Canada balsam is added sufficient to procure the proper dilution of the corpuscles. A drop of the balsam is then put on a slide, covered with a cover-glass, and is then ready for use.

Mr. E. L. Fullmer, of Ohio State University, has had considerable experience in mounting small Coleoptera and other small insects, and in the pages of the *Journal of Applied Microscopy* he briefly describes the more successful of his methods. That which gives the best results for general work is as follows: drop the specimens into absolute alcohol, and leave for an hour or more to dehydrate, transfer to xylol for a few minutes to clear, and mount in balsam. To make opaque objects transparent, boil in caustic potash for a moment, and then treat as above described. In working with scale insects, the insects are first picked out of the scales and placed upon a slide where it is desired to mount them. A few drops of a five per cent. solution of caustic potash are applied, and the specimens boiled in this for two or three minutes by holding them over a bunsen flame, after which proceed as above.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* KNOWLEDGE.]

NOTES ON COMETS AND METEORS.

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

BORRELLY-BROOKS'S COMET.—This comet is now exceedingly faint, the brightness on November 1st being only ·03, as compared with 1 at the time of discovery. Its position is 6 degrees east of α Draconis at the beginning of November, and the comet is travelling very slowly in an easterly direction.

PERIODICAL COMETS.—Barnard's Comet (1884 II.) and De Vico-E. Swift's Comet (1844-1894) are possibly visible in very powerful telescopes, but the conditions are not favourable. No announcement has been made at the time of writing that either of these objects has been redetected in the large instruments which are doubtless being employed for the purpose. Amateurs provided with ordinary telescopes must wait for future returns when these comets will be better presented. In *Ast. Nach.*, 3664, Mr. F. H. Seares gives a continuation of his finding ephemeris for De Vico-Swift's Comet, and from this we extract the following:—

Date.	R.A. H.	R.A. M.	R.A. S.	Dec. °	Dec. ′	Distance in Millions of Miles.
November 16	18	44	57	25	48 S.	224
" 28	19	16	12	24	54 S.	227
December 14	19	59	39	23	2 S.	231

The perihelion passage will take place on February 13th, 1901, but the comet will be too near the sun for it to be observed.

FIREBALL OF SEPTEMBER 2, 6H. 54M.—About 35 accounts of this brilliant object were received, but they were not very definite as regards the particulars of the phenomenon. Some of the descriptions have, however, afforded a satisfactory means of comparison. Adopting the ζ Cepheid radiant at 334° + 57° as best representing the observations, it appears that the meteor became visible at a height of 85 miles over Richmond, Yorks., and ended at a height of 20 miles over a point near Fleetwood, Lancashire. Its length of observed course was 84 miles. It was certainly one of the largest and most brilliant meteors seen during the year. Its sun-lit streak remained visible for more than half-an-hour, and formed one of the most striking features of the event. It is remarkable to find that the discordances among the various observers are very great in regard to many of the details. Three of the observers give the time as about 6 p.m., while another mentions 6.15 p.m. Five others give the following times, 7h. 0m., 7h. 15m., 7h. 20m., 7h. 30m., 7h. 30m. Yet it is certain from the rough descriptions of the path that only one meteor was observed and that the correct time was as nearly as possible 6h. 54m. With regard to the streak or train left in the meteor's wake, several correspondents say there was none whatever visible. Three state that there was a trail which remained in sight about 5 minutes, several give the time of its duration as 10 minutes, two others watched it for 30 minutes, while at Wetherby it remained in view until 7h. 30m., or 36 minutes after the meteor flashed across the sky. Some of the observers were much struck with the apparent proximity of the fireball, and thought that it must have fallen within two or three hundred yards of the spot where they stood. People in Yorkshire, Lancashire, Scotland, and Wiltshire were similarly impressed. In Wiltshire a party of observers thought the fireball must have alighted in a field about a mile off, while at St. Andrews, Scotland, it seemed to fall in a field of turnips close to the observers. The descriptions vary so much as regards the time and position of the object that several large fireballs would, on first consideration, appear to have appeared on the evening in question. There is no doubt, however, that there was really only one, but that some of the accounts are inexact, and this we might naturally expect, as most of the observers were inexperienced and must have been taken by surprise at the suddenness and brilliancy of the apparition.

Fireball of September 16, 8h. 44m.—A fine meteor, brighter than Venus, was seen at this time by Mr. W. E. Besley, of London, Mr. J. Gilbert Wiblin, of Oxford, Mr. Chas. Parker, of Handsworth, near Birmingham, and Mr. T. Harries, of Llanelly. The observations are in satisfactory accordance, and show that the radiant was in 324° −25° between Capricornus and Piscis Australis. The meteor fell from a height of about 50 miles above Bewdley, to 32 miles above Wigan, and had a visible path, as observed, of about 86 miles. But it is probable that the real length of path was greater than this, for the observers did not see the meteor until it had traversed a section of its course.

Observations of Shooting Stars in September.—The month was highly favourable for astronomical observations. At Bristol, 127 meteors were seen during 17 hours of watching distributed over 10 nights. Both at the opening and closing of the month there were active radiants at 333° +56°, 71 +65, and 47 +43. During the last week in September showers were seen from 6 +11, 23 +57, 27 +3, and 75 +32.

The November Meteors (Leonids).—Observers should look out on the mornings of the 14th, 15th, and 16th, as it is quite possible, notwithstanding the failures in preceding years, that a fine display may be presented. We are not yet sufficiently acquainted with the stream in its past vicissitudes or present and future developments, to speak positively as to whether the shower will or will not return in great brilliancy this year. Nor is it possible to say exactly when or where the display will be visible to the best advantage should it return. But the morning hours of November 15 appear to be the most promising, and will be likely to furnish a rich shower, if not a really grand display, though the moon will be visible in the same region of the sky as the radiant point. She will, however, be in her last quarter, and ought not to seriously interfere with successful observation.

THE FACE OF THE SKY FOR NOVEMBER.

By A. Fowler, f.r.a.s.

The Sun.—On the 1st the sun rises at 6.55 and sets at 4.33; on the 30th he rises at 7.44 and sets at 3.51. There will be an annular eclipse on the 22nd, invisible at Greenwich, the line of central eclipse passing across South Africa, the Southern Indian Ocean, and Western Australia. At the Cape of Good Hope, a partial eclipse, magnitude 0,492, will be visible, and at Natal a partial eclipse of magnitude 0.717.

Sunspots are not likely to be either large or numerous.

The Moon.—The moon will be full on the 6th at 11.0 p.m., will enter last quarter on the 14th at 2.38 a.m., will be new on the 22nd at 7.17 a.m., and will enter first quarter on the 29th at 5.35 p.m. The principal occultations visible at Greenwich are as follows:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
									d. h.
Nov. 5	π Arietis	5·6	4.53 p.m.	89	75	[illegible]	274	[illegible]	14 9
,, 12	λ Cancri	5·6	11.54 p.m.	100	129	12.58	289	28	20 1[illegible]
,, 29	κ Piscium	5·0	6.11 p.m.	21	28	7.7	281	247	8 12
,, [illegible]	16 Piscium	5·6	11.23 p.m.	[illegible]	50	12.14	229	181	8 17

The Planets.—Mercury will be in inferior conjunction with the Sun on the 20th, and will be a morning star throughout the remainder of the month. He is, however, not very favourably situated for observation in our latitudes.

Venus is a morning star, rising shortly before 3 a.m. at the beginning of the month, and about 4.15 a.m. at the end. On the 15th, three-quarters of the disk will be illuminated. The path of the planet is from near β Virginis to κ Virginis, passing a point about 4° north of Spica on the 21st.

Eros traverses a retrograde path through the northern part of Perseus into Cassiopeia, and is visible throughout the night. The following ephemeris, for Berlin midnight, may be useful:—

	True Right Ascension.			True Declination.	
	h.	m.	s.	°	′
November 1	2	15	8	+53	51·1
,, 6	2	5	7	54	17·5
,, 11	1	54	51	54	18·9
,, 16	1	45	9	53	54·5
,, 21	1	36	54	53	5·2
,, 26	1	30	48	51	53·7
December 1	1	27	20	50	23·8

At the beginning of the month this planet will be about equal to a star of magnitude 9·5.

Mars is becoming better situated for observation at convenient hours, rising on the 1st just before half-past eleven, and on the 30th shortly after half-past ten. The path of the planet is easterly through Leo, and on the 18th the planet will be 1½ degrees north of Regulus. On the 15th, the illuminated portion of the disk will be 0.896, and the planet will be 125 millions of miles from the earth.

Jupiter is rapidly approaching conjunction with the Sun, and can only be observed under very favourable circumstances. On the 1st he sets about 6 p.m., and on the 15th at 5.23 p.m.

Saturn may still be observed for a short time in the early evening. During the month the planet traverses a short easterly path in Sagittarius, nearly between the stars λ and μ. On the 1st he sets at 7.24, and on the 30th at 5.40 p.m.

Uranus is too near the Sun to be observed.

Neptune, in Taurus, is visible throughout the greater part of the night, rising on the 1st shortly after 7 p.m., and on the 30th soon after 5 p.m. The path of the planet is a short westerly one, nearly midway between 132 Tauri and Eta Geminorum.

The Stars.—About 9 p.m. at the middle of the month, Gemini will be low in the north-east; Auriga and Perseus high up in the east; Taurus between east and south-east, with Orion below; Aries nearly south-east; Cetus nearly south; Andromeda and Pisces in the south; Cassiopeia almost overhead; Pegasus and Aquarius towards the south-west; Cygnus and Aquila in the west; Lyra a little north of west; Corona setting in the north-west; and Ursa Major below the pole.

Minima of Algol occur at convenient times on the 1st at 9.11 p.m., on the 4th at 6.0 p.m., on the 21st at 10.53 p.m., and on the 24th at 7.42 p.m.

Chess Column.

By C. D. Locock, b.a.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of October Problems.

(W. Geary.)

No. 1.

1. Kt to B5, and mates next move.

No. 2.

Key move—1. K to Ksq.

If 1. . . . B to B5, 2 Kt to Kt4
1. . . . P to B3, 2. Q to Q8ch.
1. . . . P to K6, 2. Q to B6ch.
1. . . . Any other. 2. P to K3.

[This problem has been much and deservedly admired.]

CORRECT SOLUTIONS of both problems received from W. de P. Crousaz, H. S. Brandreth, Alpha, G. A. Forde (Capt.), H Le Jeune.

Of No. 1 only from J. T. W. Claridge, H Boyes, Major Nangle.

H. Boyes.—In reply to 1. K to B2, Black has a valid defence in 1 . . . B to B5. If then 2. P to K3, B to Kt I; or if 2 Kt to Kt4, P to K6ch. It is a very good "try."

P. A. Cobbold (Ontario).—Your solutions of the September problems are quite correct. Yes, most experienced solvers make use of the diagram only, at any rate for two movers. When White has a choice of moves at any stage after the first move the result is a dual, *e.g.*, in the September problem (No. 2), after 1. P to Kt5, Kt (K8) moves, there would be dual mates in answer to four different moves of the Knight if the Black Rook at R8 were removed. That is, there would be four duals. A dual on the *first* move is generally known as a "cook," and of course ruins the problem.

Major Nangle.—See reply to H. Boyes. Many thanks for the problem, which shall be examined and published if sound.

J. J. Allen.—Problem received with thanks. You are perfectly correct with regard to Mr. Gundry's problem in the June number. How the flaw came to be overlooked is difficult to say.

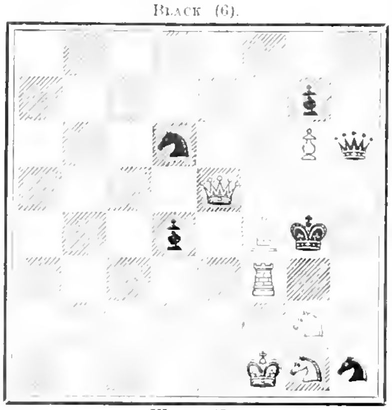
After an interval of three or four months, it has remained for Mr. J. J. Allen, of Calcutta, to point out a flaw in Mr. W. H Gundry's problem, published in the June number. In reply to 1. KtKt3, Black can play Q to QKt3ch, and there is no mate. It is very strange that this should have escaped the notice of not only the composer, but the band of regular solvers, to say nothing of the Chess editor. As Mr. Allen suggests, the problem may be rendered sound by placing the White King at Kt2 instead of Ktsq.

PROBLEMS.

By P. G. L. F.

No. 1.

BLACK (6).

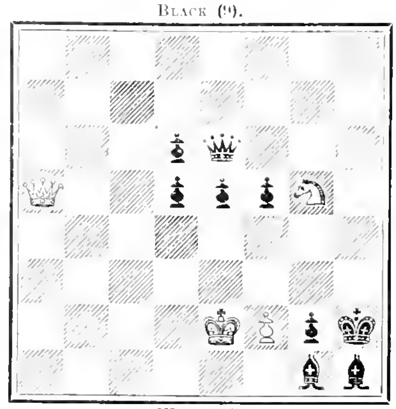


WHITE (7).

White mates in two moves.

No. 2.

BLACK (9).



WHITE (4).

White mates in three moves.

CHESS INTELLIGENCE.

I omitted to state last month the result of the tie for the first three prizes in the Munich Tournament. Maroczy, after losing one game, retired owing to ill-health, and had to be content with the third prize. This left Pillsbury and Schlechter equal first and second, and the tie-match between them resulted in a win for each, and two games drawn They accordingly divided the first and second prizes. This is certainly Herr Schlechter's finest performance in tournament play. He seems to have overcome to a great extent the tendency to draw, which at one time earned him the well-known title of the "drawing master," a title which, by the way, was originally held by his fellow-townsman, Herr Englisch.

A copy of the third edition of Mr. James Mason's "Principles of Chess" (Horace Cox) has been sent for review. The merits of the book, and the greater portion of its contents, are, or ought to be, so well known that little more than the fact of the appearance of this the latest edition need be mentioned. It has been revised and enlarged to the extent of 327 pages. The appendix contains some interesting exercises on stalemate, the fifty-moves rule, and a scheme for calculating the value of drawn games in tournaments. Mr. Mason's plan is well known to readers of the *British Chess Magazine*. It is based on the principle that won games should count 1, drawn games 0, and lost games $-\frac{1}{2}$. This would to a great extent abolish the nuisance of the "accommodation" draw, for a drawn game would approach in value nearer to that of a lost game than that of a game won. Mr. Mason has advocated this reform for the past seven years, so far without success. The book retains its former excellent binding, and still costs only half-a-crown. Evidently it will never become out of date.

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EDITORIAL.

STANDING on the threshold of a new century, whose secrets in the advance of science have yet to be unfolded, the humblest worker in the illimitable field may well look back on the achievements of the nineteenth century with admiration—perhaps with awe—as he turns his face hopefully to the work of the twentieth century. A hope that, as in past so in future decades, the arm of science may be lengthened by the force of master intellects, will urge forward, and not deter, the humble toiler in his labours.

One of the pleasing duties attaching to our position in the ranks of strenuous enquirers after truth is that of expressing our thanks to the many friends—readers and writers alike—who have aided us in our work during the past year.

In making our customary announcement of some of our projects for the new year, it is with pleasure that we note an increasing popular interest in Astronomy. In this connection Mr. Maunder proposes to continue his interesting series of articles on "Astronomy without a Telescope" under the title of "Constellation Studies." These articles will be illustrated by a set of star charts and maps, which are being specially prepared for KNOWLEDGE. Arrangements have also been completed with some writers new to our pages, who will contribute to the Astronomical work of the year. Among these, Prof. D. P. Todd, Director of Amherst College Observatory, Massachusetts, will write on "The Construction and Working of a Special Instrument for Eclipse Photography"; the Rev. A. L. Cortie, S.J., F.R.A.S., on Sunspots; Prof. A. W. Bickerton, of New Zealand University, on "The Evolution of the Solar System" and on "The Evolution of the Galaxy"; and Mr. Robert Brown, Jun., F.S.A., on "The Constellation Figures in Greek Coin Types."

We hope to publish early in the year the first of a short series of illustrated articles on "Waves," by Mr. Vaughan Cornish, descriptive of his investigations during the past six years on the Chesil Beach, the Sand Dunes in Egypt, the Goodwin Sands, and other places. These articles will be in continuation of the writer's former series of papers on "Waves," which appeared in our columns some years since.

Arrangements have also been completed for a series of six articles on the Insects of the Sea, by Mr. G. H. Carpenter, B.Sc., and a series of six popular papers on Flowering Plants, by Mr. R. Lloyd Praeger, who will take for his subjects the struggle for existence, plant dispersal, and the flora of Ireland. Mr. R. Lydekker, F.R.S., will contribute to the January number an illustrated article on Monkey Hand-prints, to be followed by a paper from the same pen on the Identification of Individuals by means of Finger Prints. The Rev. T. R. R. Stebbing, F.R.S., has promised to write on some singular groups of *Arthropoda*; the Rev. J. M. Bacon, M.A., F.R.A.S., on "Storms and Storm Clouds as Observed from a Balloon," and "Bells and their Value as Warning Signals"; and Mr. Harry F. Witherby will recount some of his experiences in a recent ornithological expedition to the White Nile.

Contributions in Astronomy are also promised by Mr. A. C. D. Crommelin, Mr. John Evershed, Mr. A. Fowler, Mr. J. E. Gore, and Prof. E. C. Pickering; and on Colour Photography, by Mr. H. Snowden Ward; on Rockall, by the Rev. W. S. Green; on Standard Silver, by Mr. Ernest Smith; and in Geology, by Prof. G. A. J. Cole. Mr. W. F. Denning continues his interesting column on "Comets and Meteors," and Mr. Fowler will foretell, as heretofore, "The Face of the Sky" month by month.

Following the announcement in our Chess Column in the present number, Mr. C. D. Locock will commence a Solution Tourney in the January issue, and we hope to publish original articles on the game from the pens of some leading players during the year.

We have also arranged with Mr. M. I. Cross, the joint author with Mr. Martin J. Cole of the well-known "Handbook of Modern Microscopy," to conduct the column on Practical Microscopy during the year.

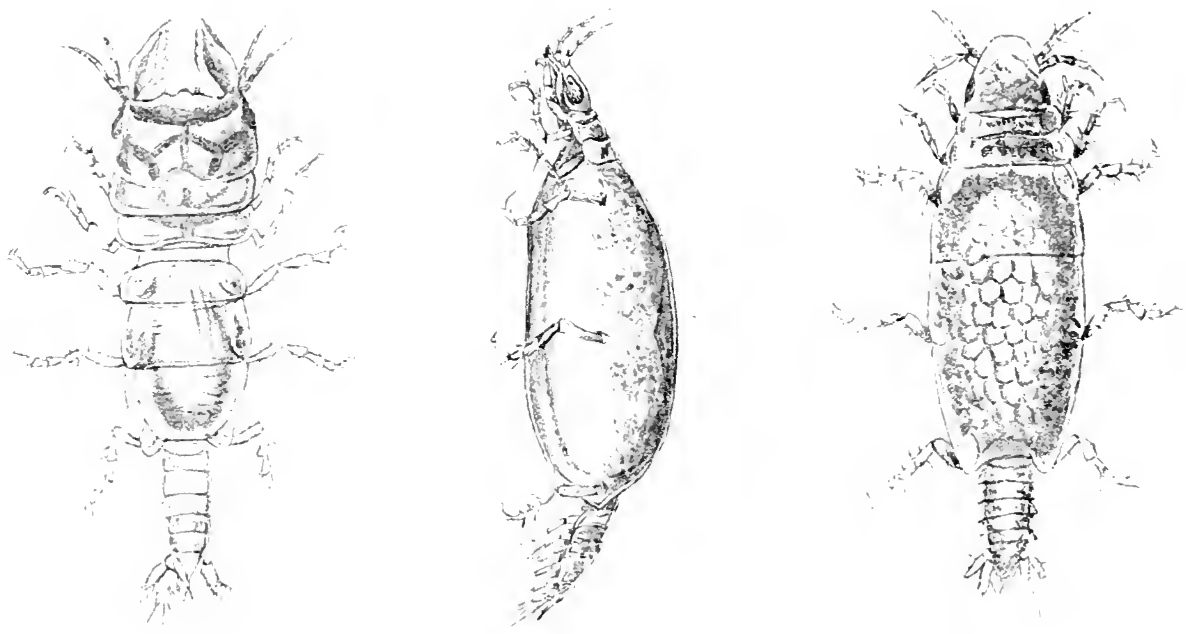
THE KARKINOKOSM, OR WORLD OF CRUSTACEA.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

CRUSTACEAN NURSERIES.

To be rocked in the cradle of the deep is the lot of many juvenile crustaceans, and, however forlorn it may sound, it exactly suits their constitution. So long as the brood remain attached to the mother's body, on trunk or pleon, on back or front, in pouches or free, in irregular masses or shapely packets or long pendant strings, varying arrangements of the maternal organism or mode of life provide for their health and welfare. But upon detachment, whether before or after hatching, the young pass out of the mother's care. Sometimes the separation takes place under such circumstances that the mother is sure to be dead before the birthday of her offspring arrives. Obviously in the intermediate period they cannot maintain any active struggle for existence. Many no doubt succumb, without ever a chance of climbing up the climbing wave, but quite enough survive, sheltered in safe inglorious mud, to become portions and parcels of the fateful future. Sometimes the young have habits quite different from those of their parents and of necessity live apart. Even where the display of maternal care and affection is not physically impossible, it can be little needed in this extremely prolific class of animals, and the records of it, which are partly discredited by their rarity, cannot be accepted without corroboration. There is the little globular entomostracan *Chydorus sphaericus* (Müller), of which Dr. Baird says, "According to Pritchard, the young play near their parent, and at the approach of danger swim for protection within the shell of the mother, which she, conscious of their feebleness, immediately closes." Since the mother herself is only a sixtieth of an inch in diameter, how powerful a microscope must Pritchard have used that could not only see into the maternal consciousness, but could also discern that the infants were "playing," that they had a sense of approaching peril, and that they knew where to flee for refuge! It is odd that the reciprocal affection thus pleasingly described should find no authentic counterpart in the highest ranks of the crustacea, in which they might have been perceived with some less exceptional instrument. The West Indian land-crabs must be far above any entomostraca in intellectual development, and they lay their eggs in the sea, thus leaving their young ones in a very literal sense to fish for themselves.

We speak of children as little men and women, and of men and women as children of a larger growth. Between cats and kittens there is a very close resemblance. People have been known to eat lamb mistaking it for mutton. Therefore, when an amphipod comes out of the egg a meek and miniature copy of its mother, that seems to be an ordinary and regular sort of performance. When a young woodlouse is born, a casual observer might think it a little off colour, but would probably deem it much like its parents in isopodan shape and structure, overlooking the absence of its last pair of legs or reckoning the want of two legs out of fourteen a trivial arithmetical detail. Nevertheless between the young and adult of a crustacean species there is sometimes so great a difference that science has long stumbled and stammered before recognising the relationship. To rear a species from the egg to maturity, under observation in an aquarium, may seem a facile method for dealing with any such questions of affiliation. The misfortune is that the foundlings to be operated on are in their early youth often of a very delicate constitution. Each moulting which leads them out of one shape into another is a crisis in their existence. Those who bring them up by hand must find out what temperature of the water they require, what amount of movement



A. B. C.

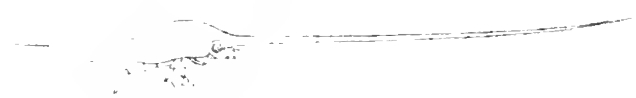
Gnathia maxillaris (Montagu). From Sars. A, Male; B, Larva; C, Female.

in it, what degree of salinity, how much light or shade they need, and what sort of food is suitable to them at each successive stage. They must be isolated, to prevent confusion with other species, and to protect them from possible enemies. If all the varying conditions of their existence were known beforehand, it might still be impossible to reproduce those conditions, but frequently they cannot be known until the problem demanding solution has been already solved.

Though the isopods are in general at birth nearly like their parents, there is a remarkable exception supplied by the family of the Gnathiidæ. This was for a long time split up into two families, until an ingenious French observer, M. Eugène Hesse, at last convinced the world, including even his opponents, that the mother and children which had been called *Praniza* were verily wife and offspring of a husband and father called *Gnathia*. Sometimes the young of this genus remain parasitic on fishes, gorging themselves, until the time comes for the greater self-restraint attending the remarkable structural changes which discriminate them as males and females. The Cymothoidæ also differ, though less strikingly, in the virgin and mature state.

In other orders many genera have been founded on forms now clearly understood to be immature. Some crustaceans pass through so many distinct stages that a single individual may belong in turn to several of these infantile genera before it becomes a veteran. A crab, for example, will often be a Zoea and then a Megalópa before assuming the features of a *Cancer* or a *Carcinus*, or whatever its full grown title may chance to be. In the luminous *Euphausia* seven larval stages demand their several names from Nauplius to Cyrtopia. The slender shrimps of the genus *Sergestes* have had many an alias, as *Acanthosóma, Elaphocáris, Sciacáris, Mastigopus*, which remain as a testimony to the trouble they have given zoologists by their fickleness of form before reaching adult life. In this particular genus Dr. H. J. Hansen has by careful examination of a very large collection arrived at a useful result. He finds that in the larvæ the eye-stalks are almost always long, the eyes rather or very large, pallid or but partially black, and more or less fungiform in shape, whereas in the adults the eye-stalks are rather short, the eyes smaller and more globular, and totally black. The young have dorsal spines, which disappear, sometimes indeed from the older larvæ, but always from the adults. Other characters are available for connecting the young of different stages and different species with their proper brothers and sisters and parents.

The great commercial value of the lobster and the obliging affability with which it so constantly visits the Scandinavian and Anglo-Saxon varieties of mankind have made its life-history a subject of successful study. Quite recently (1898) Mr. J. T. Cunningham has presented a very instructive report to the County Council of Cornwall on the methods and difficulties of lobster-rearing. Dr. Herrick in his valuable book on the American lobster (1895) explains that in the first larval stage, when the animal just escaped from the egg-capsule is only about a third of an inch long, "the body is segmented as in the adult form, the most striking characteristics being the enormous compound eyes, the conspicuous rostral spine, the spatulate telson, and the biramous swimming appendages, which, from their resemblance to the permanent swimming organs of the Schizopods, have given to this and the two succeeding forms the name of 'schizopod larvæ.'" There is food for thought, then, in a baby lobster. For whereas it is in its earliest life a schizopod, *Euphausia*, which is still a schizopod when adult, passes as above mentioned through seven simpler stages before reaching maturity. The enormous compound eyes are precisely the feature in the juvenile stage of crabs on which the supposed genus Megalopa was founded and named. The spatulate telson occurs also in the larval shrimps. The conspicuous rostral spine is not confined to young lobsters, but is a character which numbers of young malacostracans delight to display. This is very strikingly seen in the zoea of our common *Porcellana longi-*



Zoea longispina, Dana. Porcellanid larva. From Dana.

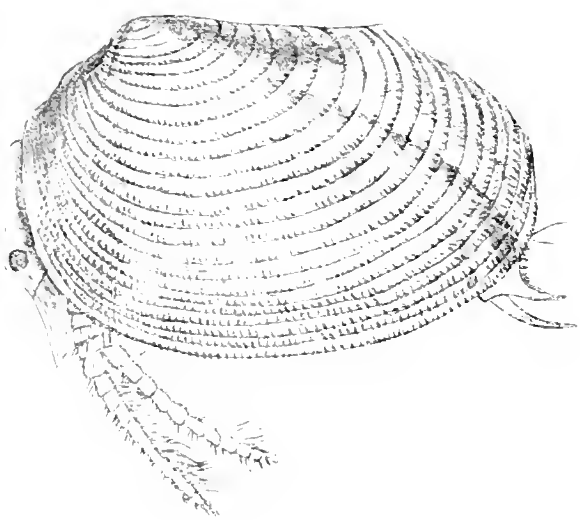
cornis (Linn.), and equally so in Dana's *Zoea longispina* from the Sooloo Sea. Dana thought that his species might be the young of an *Erichthus*, it not being known at that period that *Erichthus* is itself one of the genera founded on the young of the Squillidæ. It seems probable that the spikes with which larval crustaceans are so abundantly furnished form a defensive armour against foes of approximately their own size. The glassy transparence which many of them share with other animals that frequent the surface of the sea is also likely to be in some measure protective. Whether their large eyes are, as the wolf said to little Red Ridinghood, "the better to see you with, my dear," seems a little uncertain. Either for escaping enemies or for capturing food the small size of these larval forms and their limited powers of locomotion must put most of them much at the mercy of chance, making it rather disagreeable than otherwise for them to have a good look at the unattainable or the inevitable. Perhaps their eyes, by the impression they receive of light and darkness, are chiefly adapted to warn them of the depth of water safest for occupation at different parts of the day. But, however particular points of structure may be explained, the predominant interest lies in the diffusion of the same structures among the young of animals which at a later age are almost violently distinguished in size and shape and habits of life. Convergence of characters and the influence of environment seem inadequate to explain these phenomena, if we exclude the hypothesis that the crustacea which exhibit them have had a common origin and a slow evolution along many divergent lines from ancestors of very simple structure.

What is now common knowledge as to the metamorphoses of crustacea, at an earlier part of this nineteenth century was disputed by naturalists of remarkable eminence. As now and then happens in controversy, those who opposed the truth did so not out of sheer perversity or narrow-mindedness, but on the facts of observation—only not enough facts. We have noticed that a lobster leaves its egg-shell as a schizopod, and that a schizopod proper goes through many preliminary stages which are dispensed with in the hatched lobster. It is conceivable, therefore, that larval stages which are conspicuous in one set of crustaceans may be entirely dispensed with in another set. This is what really occurs in some of the land crabs and river crayfishes, and it was from these exceptional forms that the early opponents of crustacean metamorphosis drew their conclusions. The sea being the natural and accustomed nursery of the larval forms, it has no doubt become expedient for some of the colonists of land and fresh water to have young ones which needed such a nursery as little as possible, and which in some way got over their critical transformations while still in the ovum. The latter process must have its merits, since it is adopted by the prosperous order

Estheria packardi, Brady. Nauplius.

of Amphipoda wherever they happen to be born, which is generally in the sea.

The rearing of entomostraca from dried mud has enabled Professor Sars to trace very surely the development of several interesting forms. His figures here reproduced of the first larval form or Nauplius and the fully-grown female of *Estheria packardi*, Brady, from



Estheria packardi, Brady. Fully-grown Female.

Australia, are worth comparing with those of his own *Branchipodopsis hodgsoni* from South Africa. The two stages being the same, it will be easily seen how nearly alike are the little nauplii, and how strangely

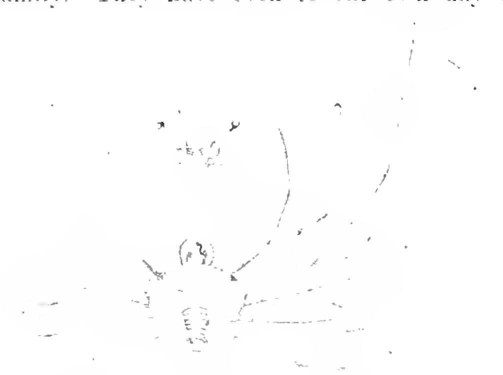
Branchipodopsis hodgsoni, Sars. Ovigerous Female.

different are the adult females of these Phyllopoda. The term nauplius, now so extensively applied in the class Crustacea, has itself an interesting history. It was originally the name of a genus invented by the illustrious O. F. Müller for some tiny Copepoda. These were really the young of *Cyclops*, and their larval character had been already pointed out by Leeuwenhoek and de Geer. But they were so unlike their parents that Müller, so far from believing in any personal identity of the young and adult forms, would not allow them to belong to the same genus. It has been explained on an earlier occasion how the connection of the cirripedes with other groups of crustacea was at length established by observation of the young, the

Branchipodopsis hodgsoni, Sars. Nauplius.

parents having carried out such extensive and eccentric transmutations that for ages they forfeited the honour of belonging to the karkinokosm.

There is still one group of juvenile forms which must not be passed over in silence. With it we may fitly conclude our discursive story of the class Crustacea. The group in question goes for the present under the designation of *Phyllosoma*, a generic name meaning leaf-body. But these laminar organisms doubtless belong not to a single genus, but are the young of many species distributed over several genera in more than one family. They have even to our own day a



Phyllosoma laticorne, Leach. Giant Scyllarid larva from New Guinea, with limbs more than five inches long. Reduced from Guerin's figure in the Crustacea of the voyage of "La Coquille."

charm of mystery clinging around them, in that we do not too well know their parents, only we know that their parentage is noble. They are not the young of insignificant creatures, but of macrurans built in the grand style, the giant crawfishes and the mother-lobsters, in other words, of the Palinuridæ and the Scyllaridæ. To be sure, in these at maturity, and in the latter family especially, there is more size and substance than attractive elegance of form. But the difference between crabbed age and youth, acting as a foil, by contrast serves to enhance the delicate beauty of the Phyllosoma. Although not gorgeous in colouring, and not tricked out in wondrous plumes, the Phyllosoma group may challenge all the crustacea of the world to surpass them in their virgin grace, and defy the glassworkers of Venice and Murano to emulate the engaging tenderness of their exquisite fabric.

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor Alfred C. Haddon, M.A., Sc.D., F.R.S.

VI.—THE REVOLUTION EFFECTED BY CORN.

In a straight line from Acre, after passing the Jordan, and the two ranges of mountains that enclose it, the traveller enters upon an immense plain, which extends to the Euphrates and Tigris. Only that portion of this plain that is nearest to the Jordan is cultivated, this is the country of the Haurân; beyond this and as far as the Euphrates it is merely a vast steppe.

The country of the Haurân, being immediately contiguous to the steppe, its population, like the Bashkirs, are peasants evolved from pastors, and it has from time immemorial been influenced by the great current of pastors traversing the steppes of Syria and Arabia.

This country is not easily cultivated, for it is not easily irrigable. Syria and the neighbouring districts are subject to a continuous dryness, owing to the prevalent winds blowing from the deserts of Sahara on the one hand, and those of Central Asia on the other. During the whole of the summer the sky is cloudless. Asia Minor, with an area five times that of France, has a volume of river-water scarcely exceeding that of France. No mountains are raised above the snow limit; scarcely has snow fallen than it is evaporated in the pure air or melting it gives rise to devastating torrents. The snow, unlike that of the Alps or Pyrenees, is not locked up to be slowly melted for the irrigation of the low-lying lands in spring and summer, but it is completely lost for cultivation.

How is it that under such unfavourable conditions these people have been constrained to transform themselves into agriculturists?

This region was formerly the sole route between the extreme East and the Mediterranean. All the merchandise exchanged between China, India, Persia, Assyria, and Arabia on the one side, and the peoples of the basin of the Mediterranean on the other, had to pass by here—it was a very cross-roads of peoples. Very numerous towns arose not only on the banks of the Tigris and Euphrates, like Babylon and Nineveh, but throughout Syria and Phœnicia, like Tyre and Sidon, and even in the middle of the desert, like Palmyra. For commerce can only be carried on in urban centres.

The development of towns by the agglomeration of the population necessitated a more intense production than that of the steppe. This was the constraint, the irresistible interest, which forced these people to agriculture. They were able to accomplish this evolution despite the obstacle of the dryness of the climate, thanks to the financial resources supplied by commerce. A very costly system of irrigation was created to supply the natural deficiency of water; the extent of the ruins of these aqueducts to-day astonish travellers. When commerce declined in this part of the world, or rather when it took another direction, there were no longer the necessary means for keeping up this complicated system of irrigation, and the town and fields were ruined, and the steppe recovered the greater part of the soil. In regions where irrigation was more easy cultivation was maintained, but with great difficulty and in a precarious manner, by utilising the ancient canals. Such was the case of the Haurân.

The chief town of the Haurân is Busra or Bosra, the Bosra of the Bible; as the capital of Roman Arabia it acquired great importance in the Græco-Roman period. The decadence of its commerce commenced with the Musulman invasion of Syria. Still flourishing at the time of the Khalifs, it was successively ruined in the 12th century by a volcanic outburst, in the 14th century by the conquerors who ravaged Asia, and later by periodic incursions of nomad Arabs. To-day the ruins of Busra occupy an extent of 1235 acres, and support a population of 300 Musulman inhabitants.

The cultivation of corn results in a social revolution. Corn, next to milk, is the most perfect food-stuff, but the nutriment is contained in a smaller volume. This concentration of nutriment permits of great accumulations of people, as it gives in a small space the means of feeding a considerable population, whilst men nourished on milk are obliged to disperse themselves over vast spaces.

Two very important characteristics of corn are that it allows:—(1) Great facility for storage. There is no comparison between the preservation of corn and that of milk, fish, or game. Thus the pastor, the fisher, and the hunter have by no means the same facility for creating riches and for accumulating the proceeds of their special industry. No food is so readily stored as corn, witness the famous granaries of Egypt, China, Italy, etc. This facility for accumulation permits provident people to possess themselves of considerable resources, since they are not obliged to consume their harvest within a short period. They can thus capitalise their products. (2) Great facility for exchange. Corn not only preserves easily, but it is infinitely divisible and travels well. The provident can utilise it for exchange, and by commerce can become rich. It is worth while to consider the immense effect of corn in history, Egypt having regular harvests, though situated between two deserts. The growing power of Russia and the Odessa corn market, and the enormous cornfields of North America.

The cultivation of corn necessitates a much longer and more difficult labour than that of garden produce. Wheat and maize especially require good soil and manure; care must be taken to select the best time for harvesting, lest the corn should get too ripe, and the weather must be carefully watched. The harvest must be got in rapidly, consequently outside help must be called in. All these difficulties and complications necessitate foresight, skill, and promptitude.

Corn also develops and complicates methods of fabrication and transport. The product, like rice, is not usually consumed in the state in which it is gathered. First the grain has to be winnowed. This is not a matter of small importance, and according as it is well or badly done so will be a corresponding difference in the return. It is a very laborious process. The four chief methods are:—(1) Threshing with a flail; (2) trampling by horses; (3) husking by pressure of a wheel drawn by cattle or horses; (4) the threshing machine. The third is the system employed by the Haurân. The family described by Le Play employed not less than ten pairs of oxen, as much for threshing as for ploughing; 1192 days' work of men and animals were occupied in ploughing, and 552 in threshing.

Corn has to be ground to flour. The heavy labour of the hand-mill everywhere falls naturally to the lot of women. As flour does not keep so well as corn it is better to grind it when it is required. In the household of Odysseus "at these hand-mills twelve women in all were wont to bestir themselves making meal of barley and of wheat, the marrow of men," and we find it termed "cruel toil to grind the barley-meal." Le Play cites a family of Russian peasants, composed of twelve persons, where the young women are obliged, in order to satisfy the needs of the community, to devote each year 100 days of labour at grinding cereals.

The flour has to be kneaded and then cooked, also heavy work that has to be done by the women, for it is only when there is an agglomeration of people that it becomes a distinct industry practised by men. Truly is bread gained by the sweat of the brow. No wonder that constraint is necessary to make pastoral peoples devote themselves to agriculture.

Agriculture requires numerous buildings and new implements. The fixed house, hay-loft, stable, cattle-sheds, which horticulture impose, no longer suffice. There is now required a barn, threshing-floor, hand-, water-, or wind-mills, kneading trough, oven, vehicles, and granaries. Compare the vast extent of prairies and small amount of gear requisite for a pastoral people, or the large acreage and small population required by a grazing farm with the buildings and equipment of an agricultural farm.

The cultivation of corn leads to an important development of transport. To make the most of every precious minute at harvesting there should be good roads; but the maintenance of roads is always a difficulty, thus in the Haurân corn is usually transported on the backs of animals in sacks made by the Beduin women of wool and goats' hair. A family that harvests ten tons of corn employs in order to transport it 120 days' work of men and 1640 days' work of beasts. The corn has to be carried from the fields to the granaries, and thence to the markets of Damascus or Acre.

This mode of life forces the families to be completely sedentary. The peasants of the Haurân still have numerous flocks, as they are on the confines of the steppes; but they do not graze them themselves, they confide them to the neighbouring Arabs, who still remain nomads. It is not without regret that they definitely renounce the pastoral life. The great Arab families settled on their lands or on Syrian towns glory in their descent from tribes still nomadic. They send their adult sons to pass several years with these tribes, in order to gain prestige.

Property in land tends to become more and more permanent as cultivation increases. As the available land is so extensive the family from year to year can put new land under cultivation. Tacitus tells us that the ancient Germans were in precisely the same condition.

The traditions of the former nomad life are very noticeable in the character and limitation of the household utensils. The furniture of the rooms is confined to some boxes and chests in which are the valuables and the mattresses and rugs. The hearth is small and portable; butter, milk, and water are kept in goatskins.

The cultivation of corn tends to limit the number of proprietors. Agriculture by becoming prolonged, more complicated, and more expensive, requires more exceptional capacities. In these societies, where external government rarely intervenes to protect the people against the attacks to which they are exposed on the part of their nomadic neighbours, it is to everyone's interest to form part of the community. Hence the incapable are absorbed by the capable—they enter into their families. These new members are not servants, they are associates, and form part of the community. They are treated as members of the family, and may marry a daughter of the house, in which case they need not pay a dowry.

The cultivation of corn does not necessarily modify the organisation of the family, it remains patriarchal. The greatest difficulty that can arise is when the family grows too big for the resources of the land; but this does not affect the peasants of the Haurân.

Trade develops. Corn is a product easy to accumulate and exchange. The families readily acquire the habit of selling their surplus and of purchasing food and other things. Thus the families of the Haurân begin to buy at Damascus and elsewhere, rice, which they eat as a treat, olive oil, various legumes which do not grow in their country, spices, sugar, coffee, etc., wooden boxes, some earthenware or iron pots, various household utensils, a few books, especially copies of the Koran, ink, pens, and paper. What a transformation has occurred from the pastoral life. The families content themselves less and less with what they produce themselves; they become partly dependent upon merchants, they are subject to the fluctuations of the market. The buying of books and of writing materials is a sign of another important modification.

Intellectual studies are developing and the teaching takes place more and more outside the family. Agricultural families feel the need of certain elementary knowledge such as reading, writing, and arithmetic, especially in relation with their trade. How for want of a little elementary knowledge the Mongols are fleeced by the Chinese traders!

Among the Haurân, unlike the Bashkirs, the functions of the schoolmaster are separated from those of the priest, a further step in specialisation. The scholastic organisation is still quite rudimentary. When, in a village of Haurân, a certain number of young men wish to learn to read and write, a teacher is procured from Damascus. Thus in each community there is usually at least one person who can read, write, and cipher. The peripatetic instructor of the Haurân and the settled teacher of the Bashkirs are the two types which persist through all societies. It is characteristic that they learn to read the Koran, and the instruction is always exclusively religious. Where the idea of the family predominates and the spirit of tradition reigns, instruction is confined to domestic and traditional religion. They fortify one another.

The sedentary life brings into contact families professing different religions. In the Haurân, Greek and Roman Christians live side by side with the Musulmans who form the bulk of the population, and who are tolerant in their relations with Christians. This tolerance is due to the patriarchal habit. Religion is almost solely a family affair. Public religion does not exist, there are no Musulman clergy. The sanctity of each family is respected.

The complications of neighbourhood mainly arise from antagonism between the nomads and the sedentary; partly a question of superiority, partly due to the encroachment of cultivation upon the steppe. The pastors make raids upon reclaimed land. The peasants of Busra are obliged each evening to drive their cattle into an immense fort, built at the time of the Khalifs for this same purpose.

It is interesting to note how the public executive arises in a population which the Turkish Government is powerless to protect. The defenders of the public peace are the very people who menace it. Each year every sheik has to make treaties with the various nomad tribes in his vicinity, and engages to pay a tax called *el khua*, "the brotherhood," the tribe thus becomes "the sister," *el ukta*, of the village. The sheik of the tribe undertakes to respect the harvests, flocks, and possessions of the peasants. The tax varies every year. The inhabitants of Busra pay about £125 annually to seven tribes. It was thus the Romans acted in regard to the barbarians when they could not repel them; they assigned territories to them upon the frontiers, paid them a tax, set them against other barbarians, and disguised this impotence by describing them under the pompous title of "Friends and Allies of the Roman People."

These series of articles may be concluded by giving M. E. Demolins' summary of the social revolution accomplished by agriculture:—

Corn is the necessary element for large agglomerations of men, for complicated societies.

It develops commerce and riches.

It modifies and complicates the conditions of cultivation.

It develops manufactures and transport.

It imposes on women their hardest work.

It transforms horses from steeds into beasts of burden and draught.

It brings about the complete substitution of a sedentary life for a nomad existence.

It renders the appropriation of the soil more permanent.

It further tends to restrict the number of proprietors.

If it does not essentially modify the patriarchal family it makes its working more difficult, and leads to a selection among the heads of families.

It causes the families to be less necessarily self sufficing and to be more dependent on commerce.

It develops intellectual culture.

It brings about a more frequent and intimate contact between families belonging to different beliefs and admits of the contact of dissidents.

It complicates the relations of neighbourhood by bringing residents and nomads face to face.

Lastly, it necessitates a greater development of government.

THE HEART OF DAUPHINÉ.

By Grenville A. J. Cole, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

The traveller may leave the busy line that thunders with the trains from Paris to Turin, may step into the Piedmont highlands at the little station of Oulx, and there, doubting if he is in France or Italy, may walk up ten miles to the *col* at Mont-Genèvre. The road climbs above the vegetation of the valley, high upon the talus of the hills; the rocks rise in crags and pinnacles, the outposts of a weird and broken region to the south, where the cañons lie brown and bare below him, like a scene in rainless Colorado. But at the pass he finds the patch of Alpine meadows, the châlets with their overhanging eaves, and the little inn with that hospitable inscription, a true motto of the frontier, "Le soleil luit pour tout le monde." On his left stands Fort Janus, grim upon its limestone crag; but his eyes look beyond it, to where, in the west, a serrated mass of snow-peaks towers in the middle air.

The stranger thinks of his map of Europe, but still asks himself, "What are these?" If he is one of the few thousands who honestly believe Mont Blanc to be in Switzerland, he is all the more surprised and fascinated. He is facing France, a land of plains and plateaux; what are these giants that arise and bar his progress?

We are, in fact, nearing the granite knot of Dauphiné, that self-contained group of Alpine summits known as the *massif* of the Pelvoux. It is an incident on the great curve of the Western Alps, which runs from Nice to Chamonix; the Grandes Rousses, the mountains of Modane, the Grande Sassière, and the Ruitor, all traversing the snow-line, connect the Pelvoux with the *massif* of Mont Blanc. The axis of the range then bends eastward, giving us the Matterhorn and Monte Rosa.

The summits of the Pelvoux are by no means to be despised. Some, at least, of our own climbers have made their mark upon them, and the fact is recorded by the "abri Tuckett" and the "Pic Coolidge" on the maps of the French Government.* La Barre des Ecrins, with its 4103 metres (13,460 feet), the beautiful peak of the Meije† (3987 metres), the Pelvoux itself (3954 metres), give us some idea of the dignity of the mass. Like most of the giants of the Alpine chain, these owe their prominence to the intrusive granite which has consolidated the mountain core, binding together the old schists into which it penetrates, and weathering out ultimately into pink-brown pinnacles and spires.

We see something of the inner structure of the *massif*, if, approaching it from the west, we leave the stratified hillsides of Bourg-d'Oisans, and enter the first grim ravine. The *route nationale* from Grenoble to Briançon here attacks the mountains by the deep channel of the Romanche. The huge precipices give us sections that are more convincing than the clearest diagrams of a lecture-room. The schists and gneisses are seen to be traversed by pale veins of granite and aplite.‡ Many of the old rocks may have been crystalline at the time of this intrusion; but the intimate penetration of the granite among them has converted many of the milder types also into gneiss. The white veins of the invader, conspicuous on the cliff that rises from the torrent, form bands many feet across; the fragments that may be picked up from the surface of the road show the same features in miniature, and bear witness to the completeness of the intermingling. Wherever the schists are thus seamed with igneous matter rich in silica, the main mass of the Pelvoux granite lies at no great distance from us.

We look up, and see green meadows, and the remote hamlet of Auris, occupying the very summit of the cliff. Here the Mesozoic strata lie across the upturned edges of the schists; and patches and infolds of them, Trias and Lias for the most part, occur even in the *massif* of the Pelvoux. Though attained only by zig-zag mule-

* Coolidge, *Alpine Journal*, Vol. V., p. 128; Vol. VII., p. 136; Vol. IX., p. 121; F. Gardiner, *ibid.*, Vol. VII., p. 80.

† First climbed by M. Castlenau; see *Alpine Journal*, Vol. VIII., p. 328. On its difficulties and general characters, see H. G. Gotch, *ibid.*, Vol. VIII., p. 177.

‡ Compare W. Kilian, "Alpes du Dauphiné et Mont Blanc," p. 22, and M. P. Termier, "Massif du Pelvoux et Briançonnais, pp. 12, 21, &c. (Livret-guide des excursions en France du viiie. congrès geol. internat., 1900).

tracks, these valued relics are eagerly seized on by the peasantry. It must be a source of much annoyance to know that the great snow-field of Mont-de-Lans covers similar stratified rocks, which have been raised too high even for the industry of a Frenchman.

The road that we have selected climbs onward to La Grave in a valley of impressive barrenness. The gorge of Gondo on the Simplon Pass possesses many similar features; but here the continuous rock, the jutting spurs without a sign of vegetation, the huge fallen rocks, unsoftened by moss and even unflecked by lichens, force on us a growing sense of desolation. Nothing now remains, as we leave the hamlet of Le Dauphin, but schist and granite, the mica gleaming on the fractured surfaces, the white veins, cold and dead, making streaks upon the great rock-walls. High up on the right, three or four little tongues of ice creep over from the unseen plateau; in front of us, a huge bare crag glows crimson, answering the sun that already has set beyond Grenoble. Then the darkness grows; the cliffs become black, save for the foaming bands of half-seen water-slides and falls, we push through lengthy tunnels, and both hear and feel the moisture dripping through the clefts; then we emerge again, as from a tomb, into a world where nothing seems alive.

Suddenly this world changes; the edges of the ice above us become, as it were, translucent, tinged with a green light from behind; on our left, the upper half of the precipices stands out, every crag and scar revealed; while across our path, and on the nearer taluses, the blackness seems to deepen, for we are still far down in the ravine, lost in the shadow of the Pelvoux. But the moon is rising, full and clear across the snows; already the light-shafts cross the valley, borne upon the tiny globules of the mist, which is too thin to be otherwise apparent; the triangular dark spaces left between these luminous bars are the air-shadows of the unseen crests.

Mile by mile, we near the close of the ravine, where a series of overfolded and repeated Mesozoic strata forms a grass-clad region, leading away to the Col du Lautaret, 2075 metres (6806 feet) above the sea. Near the hospitable village of La Grave,§ the peaks of the granite mass come into view upon the right; the moon seems poised for a moment on the very summit of the Meije, her disc intensely brilliant in the blue-black of an Alpine sky. The great snow-basins, and the glaciers oozing from them, form mysterious white masses, clinging to the highest slopes. The long Combe de Malaval is over, and the heart of Dauphiné is gained.

Next morning, in the cloudless sunlight, we can appreciate the contrast between the Jurassic strata of this pastoral upland and the granite mass of the high Alps. The former consist largely of dark and shining shales, with intercalated bands of limestone; where they are squeezed up almost to the snow-line, they appear coal-black under the white fields and the translucent masses of the ice. The storms of rain, intense at these high altitudes, have carved gullies in them, irrespective of their bedding, much like the channels cut in soft clay at ordinary levels. Above them, the granite forms a number of peaks, which long defied the climbers, with flanking *aiguilles*, such as one sees on the *massif* of Mont Blanc.

While the Mont Blanc range is an elongated mass of granite, penetrating the schists, absorbing and including them, and exposed over a distance of 40 kilometres, the Pelvoux mass is an almost circular knot, 15 to 20 kilometres across, and perhaps only the crest of a far larger subterranean dome. In both cases, the granite has been brought to light by the movements that culminated in Miocene times, while Jurassic strata have been caught up on the flanks in the form of deep or recumbent synclinals, formed during the crumpling of the rocks that lay below.‖

The ascent to the Col du Lautaret from La Grave thus shows us, far below upon our right, a valley worn in the softer rocks, extending far into the *massif*, and then closed abruptly against the broad Glacier of Arsine. A stream, the upper part of the Romanche, has laid hold of this weak band of overfolded strata, and has produced a valley 3000 feet in depth. The products of erosion are thrown out in a pretty delta against the meadows of Villar d'Arène. The granite on the east side of this Mesozoic infold is forced up by the earth-pressures until it overlies the Trias, which in turn rests on Liassic limestone; we now know that such inversions of the natural order are a frequent feature of mountain-chains. This deep synclinal between two granite masses, forming the upper valley of the Romanche, has its counterpart in the glorious Allée Blanche under the Italian aiguilles of Mont Blanc.

To the east of the Col du Lautaret, the characters of the Alpine foot-hills reappear. The brown limestone crag of the Grand Galibier reminds us of Tyrol; the mountains about the fortress of Briançon, to which we now descend, have their counterparts in the southern Juras. A band of Coal-Measures comes up in their midst, much broken and displaced; it is the same as that which contains beds of graphite on the Little St. Bernard, and which can be traced north-eastward right into the valley of the Rhône.

We now join the Durance, one of the most vehement of Alpine streams. The whole region bears witness to disastrous denudation. A few wet days in August of the present year converted it in places into a mere wilderness of stones. Already, as we come down from the Lautaret, we find one of the long tunnels broken into by a stream, and choked with *débris* from the mountains. A little further on, when we have traversed the rough track constructed on the outside of the tunnel, we find huge blocks deposited on the crown of a bridge, which has naturally given way beneath them. The former stream-hollow has, however, become filled by a land-slide, and is thus not difficult to cross. Down below Briançon, similar havoc has been wrought on the surface of the broad detrital cones, which everywhere mark the entry of the lateral streams on the main valley of the Durance. The villages, like those of Karinthia, are commonly built on the summit of these cones, which spread out, in huge shifting fans, on either side of their main axes. Wooden groins, like those set to control the movements of sea-beaches, are constructed in the more dangerous portions of the cones; here and there, the movement of the surface has broken them across, while the pebbles have poured through and over them like a flood. The country is one in which denudation can be felt; the very fields of the peasantry may disappear into the Durance, or may be buried in an hour beneath an oozing stream of stones.

The older alluvium of the valley, in which ravines have been carved by the modern action of the streams, still projects in patches from the mountain-walls; many of these masses of mud and gravel are the relics of ancient and majestic land-slides. The road has to be

§ Very different from the La Grave described by explorers thirty years ago.

‖ Termier, *op. cit.*, p. 20.

cut along vertical cliffs of what seems the most treacherous material, until it can find a firmer hold on the Jurassic or Cretaceous rock beyond.

Some of the old pebbly alluvium, however, has become consolidated as a firm conglomerate, brown and massive, breaking now into huge rectangular blocks. It is difficult to believe that this rock is of about the same age as our glacial gravels in the British Isles. It forms solid platforms in the valley, on one of which the town of Embrun stands; on another, still more imposing, the fortress of Mont Dauphin has been piled. This conglomerate has its analogue in the beds that once choked the Alpine streams, as they emerged on Bavaria¶, or on the plain of Italy.

The decay of Dauphiné under the tremendous battery of its storms is aided by the nature of the Mesozoic rocks themselves. All down the valley of the Durance, a large part of these consist of black shales, nearly as hard as slate, which yet crumble up into mere flaky powder when exposed. In these beds, the occasional thin bands of yellowish limestone alone mark the stratification. Being much contorted, they run like conventional streaks of lightning across the uniform blackness of the shales, surprising us again and again by their evidence of the original structure of the mass. In between them, and often involving them in decay, the shale weathers down like a mere rubbish-heap exposed to the wash of rain. Characteristic little cirques are worked out, by the union of the rivulets that occur during storms and rapidly die away again. Each group of these rivulets terminates in a common channel below, and the rock-mass between two adjacent channels in time comes to stand out like a steep conical earth-pillar or bluff. Whole hillsides are cut up into these pillars or earth-pyramids, as if the material was some superficial moraine, instead of the rock that builds the mountains. Probably, the alternations of storm and intense sunlight—for we are here on the latitude of Florence—have much to do with the rapidity and uniformity of disintegration. Compact shales, that in our insular climate might weather out almost like the slates of Moelwyn, are here doomed to destruction before our eyes. The pyramidal or steepy conical forms due to denudation become fascinating, and at the same time monotonous. In the wild ravine from Savines down to Espinasses, we lose sight of them with pleasure; limestone here predominates in the Jurassic series, and sheer rock-walls and terrace-structures are the result. But, at the further end, the fantastic forms return to us like an evil dream; at times the outer sides of the bluffs become rounded, resembling badly made columns, or the swollen trunks of trees. A vision of elephantiasis presents itself; whole mountains appear to be abnormally diseased. The rotten condition of the surface is seen when one of the larger side-streams cuts its way down to the Durance; the ravine made by it in the black strata repeats the characters of those carved in loose alluvium.

This valley of the Durance provides, indeed, an amazing picture of destruction. We begin to ask ourselves, what is solid, what is proof against the thunderstorm that crashes through the mountains, or against the dry heat, the glare of southern sunlight, that strikes up towards us from Provence? The enormous cliffs of massive limestone that at last rise around us, pale and ghostly in the blackness of the storm, may give us some assurance; they bring south, as a bulwark to Dauphiné, the finest features of the Juras. But our impressions of the Durance, down to the delta formations among the almond orchards of Manosque, are those of a stream pillaging a country. The dust that forms on the disintegrating surfaces in days of burning sunshine spreads itself to the leaves of the vines and to the grass of shadeless fields. Even the tiled roofs of the villages have caught the prevailing dust colour, a uniform tone of yellow earth. The bastide of Montfort is yellow on its yellow hill; the hamlets along the mountain spurs conceal themselves successfully, by mimicry of the stone-heaps from which they rose. These contrasts, between the crumbling foothills and the old Alpine core which has become pre-eminent by their decay are nowhere more brilliantly revealed than here on the outskirts of Provence. For always behind us we may catch some glimpse of the granite heart of Dauphiné; beyond the long valley, and the ruin of its walls, lies the glory of the high alp and the snows.

¶ See Knowledge, Vol. XXIII., p. 123.

THE MILKY WAY IN CYGNUS.

By Mrs. Walter Maunder.

The accompanying photograph was taken in the second week of August, 1899, during the progress of the Perseid shower. The photographic object glass used was a Dallmeyer stigmatic lens of $1\frac{1}{2}$ inches aperture and 9 inches focal length. The size of the plate is that standardized by the International Astrographic Chart, namely, 16 centimetres square, so that the area of the sky covered is about 1400°. The camera was mounted on an equatorial stand, constructed by the late Mr. Sydney Waters, F.R.A.S., for use in eclipse observation, and bequeathed by him to the Royal Astronomical Society, by whom it was lent to my husband. It was housed in a small wooden observatory, made with a roof that could slide quite away and leave as much sky room available as the other conditions of the situation allowed. This was not very great, as the garden in which the observatory was placed was small, and much surrounded by houses, which not only limited the horizon, but abounded with windows that were unpleasantly illuminated at night.

The photograph was exposed for $6\frac{1}{2}$ hours, but the exposure was distributed over several nights, and this for various reasons. In the first place, the equatorial was of the "German" form, *i.e.*, there was a counterpoise to balance the camera at the other end of the declination axis. Consequently either the camera or the counterpoise would foul the stand shortly after passing the meridian, and the instrument would have to be "reversed" in order to continue to follow the stars. This would also mean reversing the relative positions of the stars in the telescope, which in visual work would not matter, since the eye does not retain on the retina the first positions of the stars, but which in the camera would introduce new and unknown configurations of stars on the plate. And the exposure must not take place whilst the guiding star is very far distant from its meridian, since its altitude is then rapidly changing, and the area covered by the plate being very considerable the effect of refraction would vary largely over the plate, and be, moreover, variable in its change. Thirdly, and this was by no means the least important factor, the strain on the observer was very great. The guiding telescope was a Cooke refractor of $2\frac{3}{4}$ inches aperture, small but of excellent quality; the diffraction rings round the brighter stars were many and almost perfect. There were absolutely no luxuries in the shape of illumination of field or wires, not to speak of electric control to the driving clock; the observer had to be her own automatic control, and to this the strain of long continued observing was largely due. The substitute for field illumination was simplicity itself; in the eyepiece were four crosswires, and the brightest star available in the region was selected as the guiding star. The eyepiece was drawn out so as to put the star out of focus, and the spurious disk thus formed was quadrisected by the crosswires—and kept quadrisected. Of course this was supposed to be the clock's business, but here lay the great source of disaster. If the spurious star disk was not kept quite steadily on the intersecting wires, but wandered off them, then the black wires became invisible against the black sky, and all sorts of hieroglyphics might be drawn on the plate by the frantic star before the intersection was found again. The driving clock is a very valued friend, but his great value and assistance cannot blind me to his idiosyncrasies and failings, among which may be numbered a wearying in well-doing that is more than occasional. He was originally built to run for the short period that totality lasts in a total eclipse of the sun, and not for the hours that may be necessary in taking a star photograph. When he had been running for some time, and had been wound up two or three times, and was in a very good temper, I might venture to leave him to go alone for a period not exceeding 60 seconds. Twice, indeed, I have left him to his own devices for a space of time nearly five times that, but that proved to be a very rash action.

The observer's duty, therefore, was to sit as comfortably as the position allowed with one eye glued to the eyepiece, the declination slow-motion rod in the left hand and the right hand touching the slow-motion wheel of the right ascension circle. The best results were generally obtained when a direct connection seemed to be made between the eye and hand, and the connections between these and the brain apparently switched off. Usually it was fatal if I thought of what I was doing; it was much better to think of something else—something not exciting.

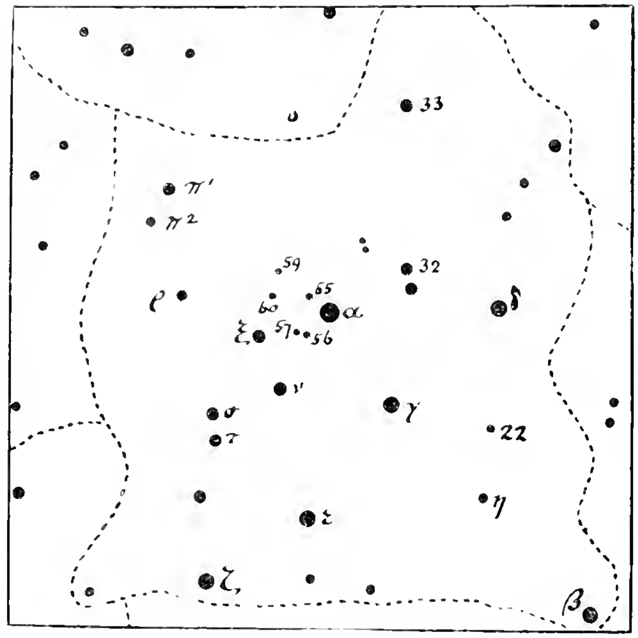
In the photograph under consideration no perceptible error in driving is to be seen; the guiding star is perfectly round, and so are the stars situated within ten degrees of the centre. During the exposure I saw many of "The Tears of St. Lawrence." I hoped that some would pass across the field of my camera, but I saw none within that region, and none have been impressed on the plate.

The photograph was taken for the purpose of studying the form and structure of the Milky Way, which may be seen crossing the plate diagonally, and is well shown throughout its greatest width. Much detail is seen on the original negative that is unavoidably lost in a process reproduction. The description is drawn from the original negative, and therefore some of the structures pointed out may not be recognisable on the accompanying Plate.

The scale of the original negative is almost exactly that of Cottam's smaller Star Charts, and the field photographed corresponds almost precisely to Chart No. 22, the constellation Cygnus.

The key-map, showing the brighter stars in the central region, is traced from the negative, but the magnitudes assigned are those of Proctor. As it will be at once seen these are very different from the photographic magnitudes, as might indeed be expected in such an actinic region as the Milky Way.

The large central star, which was used as a guide, is α Cygni, and is situated in a gap, or what might by courtesy be termed a gap, in the Milky Way. The great star belt itself seems to be divided into five fairly distinct regions. The preceding one of these is roughly crescent-shaped, with 33 Cygni and 22 Cygni in the northern and southern horns respectively, and 32, δ, γ and α Cygni lying on its borders. A small



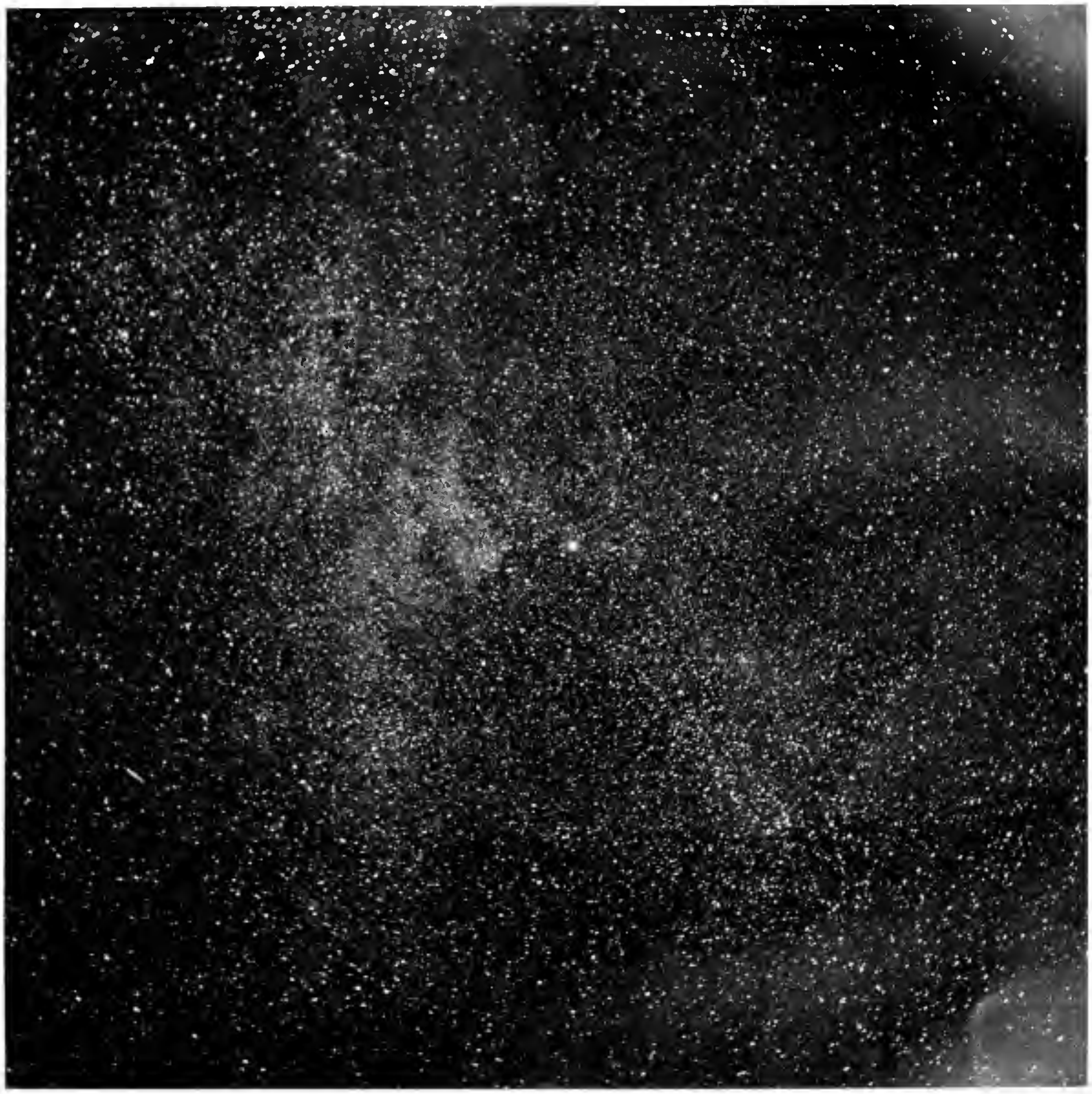
The Constellation Cygnus. Key-map to Plate.

horn, having its base resting on the stars 32 and δ Cygni, appears to point in a north-westerly direction. The whole of this region appears to be covered by a diffuse, but not uniform, faint cloud, which gives the appearance of nebulosity, but which under the microscope is seen to be, not nebulosity, but faint, fairly well defined stars. γ lies on the western border of another region, smaller but more striking, since not only are the faint stars aggregated so as to suggest a nebulous bed, but brighter stars are also massed together, giving the appearance of numerous and superimposed layers of stars whose brightness diminishes with their distance from us. More to the east again there is a huge region, not seeming to differ in its composition (as far as this negative can tell) from the two regions already mentioned except in the greater frequency of its local aggregations of both bright and faint stars, and in its more numerous channels where no stars appear or only a few sporadic ones. Such a channel, long and well-marked, separates this region (which contains the stars π^1 and π^2, ρ, ν, and ε Cygni) from another, a fainter one, and parallel to the first, still further to the east.

But the most marked and interesting region of all, is a small one on whose western border α Cygni lies, and which contains the stars 55, 56, 57, 59, and 60. To the unassisted eye this region appears on the negative to consist of a dense nebulous patch, intersected by extremely fine streaks. Under the magnifier, the nebulosity *to some extent* resolves itself into faint and fainter streams and bands of stars, these being again bound together by still fainter bonds which are *not always* resolvable into discrete stars. The streaks are some of the spaces between the streams and unresolvable bands, where no star nor connecting stuff is seen. A most beautiful and particular instance of this is to be seen in a figure of 8, formed of lines of stars and bands, immediately following 60 Cygni, and which seems

NORTH

EAST



WEST

SOUTH.

THE MILKY WAY IN CYGNUS.

From a Photograph taken by Mrs. WALTER MAUNDER, August, 1899, with a Dallmeyer stigmatic lens of 1 inches aperture and 9 inches focal length.

Field 38° side. Exposure 6½ Hours.

to form part of a complicated but well-defined 'whorl' of stars.

It seems quite clear that though the general form and structure of the Milky Way in Cygnus is well shown on this plate, no true nebulosity is shown by it over its breadth, but only apparent nebulosity due to the aggregation of small discrete stars too faint to be separately perceived by the unaided eye. It is possible that true nebulosity is photographed in the region round 60 Cygni, but that cannot be decided from this photograph alone. Possibly an exposure of 13 hours might settle the question, and some of these years I shall hope to try it if the Clerk of the Weather will some August screw the hand of his barometer to "Set Fair," and go on his summer holiday, and the moon is new; and my neighbours will go to bed early, and turn out the gas.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE COLLINS MONOPLANE TELESCOPE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The "Collins' Monoplane Telescope," described on page 252, appears to be a combination of a poor Newtonian reflector with a poor refractor. The only advantages claimed over the ordinary refractor are perfect achromatism and shortness, both which the Newtonian already possesses, without the great disadvantages of the Collins. The Newtonian requires two pieces of glass of ordinary quality, and has only two surfaces to be worked, one to a perfect curve, the other to a perfect plane, both fairly easy to test for figure, and the reflection is from surfaces of silver *not* covered with glass, and therefore brighter than any glass-covered surface, and there is no absorption of light by passing through glass.

The Collins requires two optically perfect discs of glass, of which the second must be so homogeneous that I fear practically they would be difficult to produce and exceedingly costly. If used with a silvered flat it has four glass surfaces at which light is lost, two lenses absorbing light in their substance, one of which it traverses twice, one silvered surface less reflective than in the Newtonian, and another under similar conditions as in the Newtonian. If a prism is used instead of a flat, there are six glass surfaces each taking a percentage of the light away, and the equivalent of five absorptions in the thickness of the glass. The glass surfaces have all to be worked perfect, and at least in the case of the correcting lens-mirror local correction appears to me impracticable. With ordinary refractors on a large scale, local correction is, I believe, a very important matter, and it is only on a large scale that the Collins' Monoplane's advantage of shortness would be of value.

I doubt if a good telescope of any large size could be constructed on the lines given; I doubt if it would be perfectly achromatic; and I am sure it could not equal, much less surpass, a Newtonian of the same aperture. Why then go to so much expense and trouble?

Edwin Holmes.

Mr. Holmes's condemnation of the "Monoplane" principle is far too off-hand. The idea is being made the subject of the most careful experiment and investigation, both in this country and on the Continent; and so far from dismissing it in Mr. Holmes's summary style, one of the highest authorities in practical optics in Europe is now having a large telescope constructed upon these lines.—E. Walter Maunder.

THE PHASE OF VENUS SEEN WITH THE NAKED EYE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—To see our neighbour Venus in brilliant sunshine when near her greatest elongations is, I am quite aware, nothing remarkable as a feat, but my recent experience in this connection is to myself quite unique, and its relation may prove not uninteresting to your readers. Living as I have for years past in north-west London, I have perforce had to observe sun, moon, and planets, as through the upper reaches of the dusty air of the metropolis. I have often noticed how much more transparent my air is in the month of October than it is generally at any other time of the year. Several times during the last fortnight the morning air has struck me as exceptionally clear, so much so that I remembered Venus, whose movements I had ceased to follow since her last inferior conjunction, and I determined to look her up in bright sunshine. No sooner resolved upon than accomplished. The first occasion was on the 5th instant, between 7 and 8 a.m., the sun low but brilliant. On the morning of the 11th instant I saw her again in bright sunshine at 9h. 15m., or soon after her meridian passage. At these times, as at some intermediate ones, I was chiefly interested in noting her lustre. She did not appear as a white point on a dark blue sky, but as sparkling against a rather pale blue background. Now this morning (October 15th) I observed her several times, the last occasion being as late as 9h. 50m. As before, sunshine was as plentiful as one could desire. On no adventure of this kind have I employed any aid to find her—optical or mechanical. I have simply stood in the shade of the meteorological instrument screen. Very well, then, to-day she has appeared as a small white *disc*—spurious, of course. Until about an hour ago I did not know that Venus had passed her greatest western elongation—in fact I did not think she had; hence I adjudged her a phase about equal to that of a six days old moon. But I see by the *Nautical Almanack* this evening that on this identical day 0·637 of her disc is illuminated, and this is where the curiosity enters. Her angular diameter is about 18·4″, and her distance from the earth this morning was something like 84,894,000 miles. It is laid down as a physiological fact that the smallest object to which unassisted human vision can assign a definite shape must subtend an angle of about one minute of arc. A bright point is an entirely different matter. Now I know my own sight is by no means marvellously sharp, so that I am greatly puzzled to know how the illusion of the disc originated; because, as to illumination—we see nothing at all if there is no light to see it by. It may be that the spurious disc of a star in a telescope offers an explanation; in fact, I was satisfied to accept that as such before I found this evening that nearly two-thirds of the planet's disc was illuminated this morning. But now the question arises: is it in any circumstances possible that a body subtending so small an angle could be seen to possess a definite shape, or how in such a case is the illusion—if such it be—caused? I may add my eyes seem purely emmetropic, and whilst on the one hand there is no suspicion of myopia, on the other there is nothing miraculous about them.

William Godden.

38, Burrard Road,
West Hampstead, N.W.,
15th October, 1900.

"DARK MARKINGS IN THE SOLAR CORONA."

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In reading Mr. Wesley's admirable article on the "Dark Markings in the Solar Corona" (Knowledge, October, 1900), it occurred to me that these markings may be due to the presence of dense swarms of meteoric bodies near the sun. The markings of the coronas of 1871 and 1900 seem to me to favour this view. The passage of a dense swarm of meteorites between us and the corona would, I think, show us a dark mark; but the question is, Would the markings be as dense as those described by Mr. Wesley? H. W.

Middlesbrough,
October 24th, 1900.

[H. W.'s suggestion is an obvious one; but is open to the objection that, in that case, we ought sometimes to see dark lines due to meteor-swarms projected against the disk of the sun; which we do not.—E. Walter Maunder.]

RAINBOW PHENOMENA

TO THE EDITORS OF KNOWLEDGE.

Sirs,—On the evening of September 16th, a remarkably vivid double rainbow was visible at Eastbourne from 5.30 till after 6 o'clock, and its magnificent colours must have attracted the attention of many observers.

A curious phenomena was conspicuous on the inner or violet edge of the primary bow.

I have noticed on previous occasions that in the case of brilliant rainbows the violet rays frequently reappear as a distinct band within the primary bow, and separated from it by a moderately wide unilluminated strip.

But in the case under notice the phenomenon was intensified to a remarkable degree, the violet band being clearly triple, and the inner edge of the primary bow exhibiting the following series of colours without any apparent break—viz., green, blue, violet, green, blue, violet, green, blue, violet. Occasionally there appeared to be traces of even a fourth (isolated) band of violet; but upon this point I could not be absolutely certain.

The general effect was curiously like the mouldings on a stone archway, the inner edge of the bow presenting the appearance of concentric ridges of green separated by violet hollows.

The three continuous bands, each consisting of green, blue, and violet, were clearly seen by two others whom I questioned on the subject.

In the case of the simple repetition of the violet band, I have often attributed the appearance to an optical illusion, or even to some modification of the "ultra-violet" rays, but the complicated reduplication of the phenomenon which I witnessed last Sunday has re-awakened my interest in the subject, and I should be very grateful if any of the numerous scientific readers of Knowledge, to whom the subject may be of interest, will offer some explanation of the phenomenon which I have attempted to describe. S. R. Stawell Brown.

St. John's College, Oxford
September 18, 1900.

LUNAR RAINBOW.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—It seems pretty evident from the description given by Mr. John Macintosh in your November issue, that what he saw was not a lunar *rainbow* at all, but what is usually called a *corona*. The phenomenally long duration ($1\frac{1}{2}$ hours), the smaller diameter, and the fact that the lower portion was cut off by *clouds*, all point to this conclusion; the diameter of a lunar (or solar) rainbow is, for the primary bow, always about 82°, the lower part is always cut off by the earth (except in rare cases when the observer stands on the top of a mountain peak), and anyone who has seen a bright lunar rainbow endure for more than twenty minutes or so is fortunate indeed. The following extract from my register may interest your correspondent.

"January 31st, 1893, 9.15 p.m. Beautiful lunar corona, the inner part of a brownish orange colour, and then the colours of the spectrum in order from violet to red, most clearly defined and pure."

These coronæ are really diffraction rings, and according to Kœmtz (*Cours de Météorologie*, page 424), may have a diameter of from two to eight degrees, thus agreeing roughly with your correspondent's estimate.

Harewood Lodge, Charles L. Brook.
Meltham, Huddersfield,
November 6, 1900.

The Royal Society's Medals have this year been adjudicated by the president and council as follows:—The Copley Medal to Professor Marcellin Berthelot, for.mem.r.s., for his brilliant services to chemical science; the Rumford Medal to Professor Antoine Henri Becquerel, for his discoveries in radiation proceeding from uranium; a Royal medal to Major Percy Alexander MacMahon, f.r.s., for the number and range of his contributions to mathematical science; a Royal Medal to Professor Alfred Newton, f.r.s., for his eminent contribution to the science of ornithology and the geographical distribution of animals; the Davy Medal to Professor Guglielmo Koerner, for his brilliant investigations on the position theory of the aromatic compounds; and the Darwin Medal to Professor Ernst Haeckel, for his long-continued and highly-important work in zoology, all of which has been inspired by the spirit of Darwinism.

Conducted by Harry F. Witherby, f.z.s., m.b.o.u.

Nesting-Boxes for Wild Birds.—Some details respecting the nesting-boxes which I have been in the habit of providing here for wild birds may be of interest. The boxes are of two kinds, one for the use of small birds the other for large birds. The smaller boxes are ten inches high and six inches square, made of well-seasoned oak. A hole, about one-and-a-half inches in diameter, is bored in the front of the box for ingress and egress. The roof, which is sloping, is provided with leather hinges, and thus forms a heavy lid, enabling the boxes to be cleaned and the old nests taken out every year. A few small holes are pierced at the bottom of the box for draining purposes. These boxes last for many years. We have a number about that have been up from twenty-five to thirty years. They are fixed very firmly from four to six feet above the ground against trees. They should not be exposed to the south-west, which is the worst quarter. Fixed thus near the ground and away from houses the boxes are practically never used by Sparrows. All four Tits nest in them largely, Great Tits and Blue Tits predominating. Some years nearly all the Tits using the boxes are Blue Tits, other years they are Great Tits, and a good few Cole Tits use them, but the Marsh Tits, although common here, very rarely do so. Wrynecks always use some, preferring those in open situations. They will frequently destroy a number of Tits' nests, pulling out the nests and eggs. The Tits cover up their eggs in the boxes until they begin to sit. Nuthatches also avail themselves of the boxes, mudding up the hole to suit their size and also mudding round the lid. Some years they use many boxes. This year seventeen out of twenty looked at were occupied by Nuthatches. Many other birds, such as Robins and Wagtails, are occasional occupants, especially if the boxes are old and Tits have greatly enlarged the holes in former years. Similar boxes, but twenty inches square and with double span roof with projecting eaves, are provided with a hole, four by four-and-a-half inches. These larger boxes are firmly fixed on horizontal boughs against the trunk, not facing south-west unless very sheltered, and from twenty to thirty feet high. They are used by Owls, Jackdaws, Stock Doves, Kestrels, Squirrels, and occasionally by Stoats. Nearly all the Stock Doves' nests are destroyed early in the year by Jackdaws, etc., but they rear numerous broods in late summer and autumn. Barn Owls have young in some cases up to November. Jackdaws are dreadful nuisances, as they fill the boxes up with sticks. Where the boxes are placed in woods, however, the Jackdaws are not much trouble. Barn Owls don't care for deep woods. Kestrels are occasionally very numerous, and several pairs will breed in comparatively close proximity; I have seen as many as six fighting for one box at the end of March when they first arrive. In certain years scarcely a Kestrel will nest in a box, and very few in the trees. Among the numbers of boxes in my neighbourhood, spread over a comparatively large area, it is the greatest exception to find one unoccupied, although natural nesting sites abound everywhere.—E. G. B. MEADE-WALDO, Stonewall Park, Edenbridge, Kent.

The Levantine Shearwater (Puffinus yelkouanus) at Scarborough. (*The Naturalist*, November, 1900, p. 352.) Mr. R. Fortune, of Harrogate, records that a bird of this species, now in his possession, was shot at Scarborough on September 13th. The bird is an immature female, and has been submitted to Mr. Howard Saunders for identification. The Levantine Shearwater is the representative in the Mediterranean of our Manx Shearwater, to which it is very closely allied. It has once before been obtained in Yorkshire, and on four occasions in other parts of England.

Late Brood of Wild Pheasants. At the meeting of the British Ornithologists' Club held on October 17th, 1900, Mr. W. B. Tegetmeier exhibited a nestling Pheasant only a few days old. The bird had been sent to him from Mr. Alfred Dunnage, of Dedham, Colchester. It had formed one of a brood of nine or ten birds hatched out in a hedge-row, far from any covert.

An Observational Diary of the Habits of the Great Plover (Oedicnemus crepitans) during September and October. By Edmund Selous. (*Zoologist*, 1900, April, pp. 173-185, June, pp. 270-277, October, pp. 458-476.) The writer of this diary is at great pains to tell us precisely and minutely what happened at every moment in which he watched some Stone Curlews through September and October in East Anglia. We cannot help thinking it a mistake to print a note-book. Mr. Selous could have given us a more valuable and practicable contribution by extending his observations of the Great Plover to other months and other localities and then writing a summary, such as he gives at the end of these articles, enlarged and with a few quotations from his notebook. Among the conclusions arrived at concerning the habits of the Great Plover in September and October by Mr. Selous, we may mention that they have regular places of assembly during the day. At sundown falls they indulge in excited motions which are [illegible] cries, accompanied by their loud wailing notes. During the night they spread over the general surface of the country, returning to their places of assembly at very early dawn.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Notices of Books.

THE BIRDS OF IRELAND. By Richard J. Ussher and Robert Warren. (Gurney and Jackson.) Illustrated. 30s. This is a book for which British ornithologists have waited long, and their patience is now amply rewarded by the production of a work of a thoroughness, accuracy, and completeness such as could only have been arrived at by many years of labour. Up to now Thompson has been the only author to treat of Irish ornithology in detail. His publication appeared fifty years ago, at a time when the Natural History of Ireland was sadly neglected. Of late years Irishmen have paid increasing attention to the fauna and flora of their country until the band of workers in this direction, although still small, is now one of which any country might be proud. Amongst these the authors of the present volume must by no means be counted least. They have attacked their subject in a thoroughly masterly way, and a book of exceptional excellence is the result. As the authors' object was to compile a local avifauna, they have wisely decided not to attempt to give a complete account of any species, nor to describe the birds themselves. The distribution of each species within the island is treated as the point of primary importance, and no pains have been spared in collecting, and, above all, in personally verifying, information for this purpose. The migrations of each species, as far as Ireland is concerned, is admirably dealt with, and in this the authors have received the valuable aid of Mr. R. M. Barrington, who has lately published a most exhaustive work on the subject. A list of Irish names, a well arranged table, showing the distribution of the birds which have bred in Ireland in the nineteenth century, and some excellent maps, are further good features in the work. Owing to its geographical position, upon which depend its climate and the character of its land surface, Ireland offers a marked and interesting difference from England in its avifauna. Many birds common in England are either not found, or are very rare, there, a fact which is especially noticeable in many of our summer migrants which do not travel so far west, and in such birds as woodpeckers and the tawny owl, which require large old timber in which to breed. Thus Ireland is not so rich in species as Great Britain, but it is nevertheless rich in bird-life. Its extensive moors and lakes, its high cliffs and numerous estuaries are populated with a host of birds many of which are unfamiliar to most Englishmen, and its woods, although small and comparatively young, are the regular nesting haunts of such birds as siskins and cross-bills, which very rarely breed in England. Another fact of great interest is the increase of late years in Ireland, as breeding species, of such birds as the starling, wood-cock, magpie, and mistle thrush. All these points receive special attention in the present volume, and are authoritatively dealt with. In sincerely congratulating the authors upon the universal excellence of their production, it is only fair to state that the greater part of the work is that of Mr. Ussher, and therefore to him is due the larger amount of praise, but in saying this we do not for a moment suggest that the portions of the volume for which Mr. Warren, who is an accomplished ornithologist, is responsible fall in any way short of the high standard attained in the rest of the work.

A TREATISE ON ZOOLOGY. Edited by E. Ray Lankester. Part II. The Porifera and Coelentera. By E. A. Minchin, G. H. Fowler, and G. C. Bourne, with an Introduction by the Editor. (A. and C. Black.) 15s. net. The second instalment of this great work, which in serial order precedes the part on the Echinoderma, issued last March, and already noticed in this journal, fully maintains the high standard of the latter. Like its predecessor, it is bristling with technicalities, and is not to be regarded as a book on popular natural history which can be taken up and read during any spare half-hour. It is essentially a work for the serious and advanced zoological student; and from this point of view is everything that can be desired. Without for one moment underrating the excellent systematic work of the three gentlemen whose names appear on the title-page, it must be acknowledged that the great feature of the present volume is the exhaustive essay by the editor on the "Cœlom." Those of our zoological readers who have reached middle age will recollect that in their college days they were taught that the pleuroperitoneal cavity of the higher animals was formed by the splitting of the mesoblastic layer of the embryo, so that the cavity in question was in no sense a morphological unit. Professor Lankester now demonstrates in the clearest manner how the cœlom (as the pleuroperitoneal cavity is now termed) is developed as a pair of buds from the primitive intestinal tract, and is originally a receptacle for the internal generative organs. It is therefore essentially a morphological factor of prime importance in the animal series, and one which justifies the separation of animals of higher grade than the sponges into two divisions, according as to whether the cœlom is or is not differentiated as a distinct cavity. Whether, however, the names "Enterocœla" and "Cœlomocœla" are the happiest that could have been selected for the groups in question is one on which a difference of opinion may be permissible. To follow the editor through his account of the history of the realisation of the true nature of the cœlom (an investigation in which he himself has played a leading part) would manifestly be impossible on the present occasion. But we may draw the reader's attention to the admirable description of the diminution of the size of this cavity in the Mollusca and Arthropoda, and the proportionately large development of the blood-vascular system at its expense. And mention should likewise be made of the remarkable investigations by Mr. Goodrich concerning a communication between the cœlomic and blood-vascular systems in the leech. Following on this epoch-making essay, which forms Chapter II. of the entire work, Mr. Minchin describes in an excellent manner the sponges; while in Chapters IV. and V. Mr. Herbert Fowler discusses those polyps which used to be called Hydrozoa, Mr. Bourne being responsible for the Sea-anemones, Corals, and Ctenophora, to which the two final chapters of the volume are devoted. A feature of the volume is the beauty and excellence of the illustrations, which have for the most part been prepared expressly for the work, and all of which are admirable examples of the manner in which minute structures should be figured. In only one case (Fig. 11, p. 20) have we noticed a discrepancy between the lettering of the figures and the accompanying description, and there it is but slight. Another feature is the presence of a separate index to each section of the work. To some readers, at any rate, the addition of a glossary would be a distinct advantage; but this is the only improvement we can suggest on what is in every way an admirably conceived and admirably executed undertaking.

A Romancer's Local Colour. By S. R. Crockett. Newman and Guardia. That innumerable host of very amateur photographers who affect to find pleasure in chasing, and, as they express it, "snap-shotting" men and objects, is rapidly becoming a nuisance to the more retiring and modest section of the community. A perusal of this light and humorous pamphlet may, perhaps, infuse some purpose into the methods of such photographers. It is scarcely necessary to add that, unlike the methods, cameras need not be changed—for, of course, the eminent novelist is, in his own words, "no special pleader" for the wares of Messrs. Newman and Guardia.

The Scientific Foundations of Analytical Chemistry. 2nd Edition. By W. Ostwald, Ph.D. Macmillan. 6s. net. Prof. Ostwald is well known as author of several valuable works on chemistry and chemical philosophy, and as a proof of his popularity among advanced students it is only necessary to mention that the first edition of the volume under notice has been translated into four languages. The book will commend itself to all who wish to know the why and the wherefore of the reactions which take place in the multifarious operations of the chemical laboratory. Our author says "a scientific foundation and system of analytical chemistry have hitherto failed us because the general knowledge and laws necessary for these have not been at the disposal of scientific chemistry itself. It is only within the last few years that it has become possible to elaborate a theory of analytical reactions." Prof. Ostwald is to be congratulated on the production of this book, which enables the student to work out his analyses, not by rule-of-thumb, but in an intellectual manner. The book does not pretend to be comprehensive, and, indeed, there is plenty of scope for amplification. The subject up to the present time has received scant attention at the hands of analytical chemists. Dr. M'Gowan has succeeded in supplying an able English translation.

A Handbook of Photography in Colours. By Thomas Bolas, Alex. A. K. Tallent, and Edgar Senior. (Marion & Co.) Illustrated. 5s. It is interesting to note that the firm of Marion & Co. were the first to publish a work on trichromatic photography. At that time (thirty-one years ago) the process was in its extreme infancy, but now photography in colours may be said to be an accomplished fact. A perusal of the volume before us convinces us that an exhaustive treatise on this late development of the photographic art has at last been made available to the public. The work is divided into three sections, one of which is credited to each of the three authors respectively. In the first section a history of three-colour work, and a general survey of the many processes of colour photography, is presented, and it will be surprising to many to learn that the art of producing photographs in colours was carried out in a very crude fashion long before ordinary photography came into general use. In the next section, which is the largest in the book, instructions are given for carrying out experiments in colour photography. They were compiled from lecture notes made by Mr. Tallent for use in the Polytechnic classes, and will be valuable to those who wish to acquaint themselves with the practical details of the art. The remainder of the volume is occupied with a description of Lippman's Process of Interference Heliochromy. It was in 1891 that Lippmann, a French physicist, announced that he had been able to take direct photographs in the camera showing the spectrum in the true colours, and since that time rapid progress has been made.

"Astronomical and Physical Researches made at Mr. Wilson's Observatory, Daramona, Westmeath." There is one type of observatory which seems almost peculiar to the British Isles. Private observatories there are in plenty in other countries, well equipped, and more or less well-financed by wealthy men, and extremely well worked by able astronomers, but in the British Isles we find, over and over again, that the amateur astronomer of means not only equips the observatory and provides for the carrying on of the observations, but is also himself the worker, giving his brain, and, it may be, his all too scanty leisure to the furtherance of his science. The observations at Daramona have been carried out solely by Mr. Wilson and the occasional assistance of his personal friends, Dr. A. A. Rambaut, Prof. Fitzgerald, Prof. G. M. Minchin, and Mr. P. L. Gray. They are practical researches into the difficult problems of solar physics where *a priori* reasoning becomes worse than useless, since it is impossible to realise the actual conditions in a laboratory. The principal instruments used were a 24-inch silver-on-glass mirror of 10½ feet focus, a large polar heliostat having a plain silvered mirror of 15 inches diameter, a modification of Prof. Joly's meldometer, and a modification of Prof. Boys' radio-micrometer. Perhaps the most important and fundamental series of researches carried out were those on "the effective temperature of the sun." Here the general idea was to endeavour to *balance* the heat of the sun by means of an artificial source of heat at a high known temperature, and the method employed was purposely simple. Taking Angström's estimate of the loss in the earth's atmosphere, and the probable loss in the sun's atmosphere, as found in the paper by Mr. Wilson and Dr. Rambaut, on "The Absorption of Heat in the Solar Atmosphere," the effective temperature of the sun comes out as between 8000° C. and 10,000° C. In the paper by Mr. Wilson and Prof. Fitzgerald on "The Effect of Pressure on the Temperature of the Crater of an Electric Arc," a suggestion is made which bears, perhaps, on the cause of opacity in the solar atmosphere. The arc and the surrounding atmosphere were enclosed in a steel tube, closed at its end by a lens, and when the atmosphere was under great pressure, powerful convection currents were set up, and these currents scattered the light just as snow does, or any finely-divided transparent body immersed in another of a different refractive index. Light trying to get through is reflected backwards and forwards in every direction, until most of it gets back by the w[illegible] ... matter, Mr. Wilson suggests, it may [illegible] solar atmosphere which is at high pressure [illegible] currents, or currents of different kinds of [illegible], would reflect back to the sun any radiations coming from below, and reflect to us only the feeble radiation coming from outer planetary space. This may serve to explain the darkness of sunspots wholly or in part, but it also serves to emphasise our powerlessness to conceive the conditions existing below the sun's photosphere, our powerlessness to conceive why, in a gaseous body, practically isolated and cut off from disturbance by any other, there should be local heats and pressures, quite temporary in their character, to set up convection streams and currents. As an appendix to his most valuable work, Mr. Wilson has added a few specimens of the stellar and nebular photographs taken with his 2 foot reflector. That they are very beautiful it is almost superfluous to say. From the point of view of beauty, and perhaps, also, from the point of view of scientific value, we prefer the unenlarged photographs to the enlarged ones. As, for example, in the two photographs of the "dumb-bell" nebula in Vulpecula—one ten times the scale of the other—the larger copy loses completely the faint delicate nebulosity that fills up the space between the bounding intersecting circles, and thereby changes entirely the actual form and character of the nebula.

Oldest Books in the World. By Isaac Myer, LL.B. Illustrated. (Kegan Paul.) 30s. net. The title page of this ponderous volume describes the contents as "An account of the religion, wisdom, philosophy, ethics, psychology, manners, proverbs, sayings, refinement, etc., of the ancient Egyptians; as set forth and inscribed upon some of the oldest existing monuments, papyri, and other records of that people, from the earliest historic times to A.D. 64; together with facsimiles and translations of some of the oldest books in the world. Also a study upon the origin, antiquity, and elevated ethics of the book written long before the Hebrew Exodus, now called the CXXVth chapter of the Book of the Dead, with an analysis of the same based on a comparison of numerous papyri copies; also a description of the Psychostasia, or trial of the conscience of the dead; with many illustrations of the same from the ancient monuments and papyri." The scope of the volume is thus sufficiently defined, and the main object seems to be to show, by extracts from archaic Egyptian writings, that the maxims and moral code of the ancient people of Egypt compare favourably with doctrines and ideas which have since been adopted. Thanks to the enlightened policy of the authorities of the British Museum, many people are now familiar with the chief facts of Egyptology and the chief compositions of the various dynasties. The "Book of the Dead" referred to above is a collection of chapters or separate compositions of different lengths found in Egypt inscribed upon pyramids, upon the walls of tombs, upon sarcophagi, and coffins, and amulets that were buried with the dead, and also found written upon long rolls of papyri which were placed in the tomb with the deceased. In the volume before us, fifteen writings are brought together, and different renderings are given of the original text. To students of religion, philosophy, ethics, and everyone else interested in the study of the thoughts and customs of men, the book is a desirable production, if only as an analysis of early beliefs and a reproduction of ancient writings.

We have received from Mr. Murray the first two numbers of the "Monthly Review" (2s. 6d.), and we are pleased to associate ourselves with the congratulatory chorus of our contemporaries in welcoming so handsome an addition to the monthly magazines. The turn out of the book more than realises the promises of its prospectus, and fully maintains the high traditions of the Albemarle Street house; while its Editor may be congratulated on the varied and interesting character of its contents. So high a standard of literary excellence will certainly command a distinguished future.

The advent of the "Knowledge" Diary and Scientific Handbook is announced in our advertisement columns. In view of the ever increasing interest taken in the study of Astronomy, the time has come when its votaries should possess an Annual specially devoted to their needs and requirements, and it is the intention of this new venture to meet that want.

BOOKS RECEIVED.

P[illegible] Vol. IV. 1900.

R[illegible] 1800–1900.

[illegible] (H. J. Drane.) Illustrated. [illegible]

[illegible] By [illegible] (Duckworth.) 5s. [illegible]

[illegible] By Dr. A. F. Chamberlain. (Walter Scott.) 6s.

[illegible] 2nd Edition. By G[illegible] (Murray.)

Optical Tables and Data for Opticians. By Prof. S. P. Thompson. (Spon.) [illegible]

Pitman's Shorthand Year Book and Diary [illegible]

Mechanics' Wizard Pocket Diary, 1901. 6d.

Handbook for Literary and Debating Societies. (Hodder & Stoughton.) 1s. 6d.

A Heart of Romance. By Richard Marsh. (Ward, Lock & Co.) 6s.

Williams & Norgate's Book Circular, 1809–1900.

Studies, Scientific and Social. 2 Vols. By A. R. Wallace. (Macmillan.) Illustrated. 18s.

Cumulative Subject Index to General and Periodical Literature. By A. Cotgreave. (Elliot Stock.) 7s. 6d.

Photographic Optics. By Otto Lummer. Translated by Prof. S. P. Thompson. (Macmillan.) 6s. net.

Chemistry for Examinations. By H. W. Hill. (Allman.) 2s. 6d.

Songs and Lyrics. By Charles Whitworth Wynne. (Grant Richards.) 3s. 6d.

The Cape as I found it. By Beatrice M. Hicks. (Elliot Stock.) 5s.

A Brief History of Mathematics. By Dr. Karl Fink. Translated by W. W. Beman and D. E. Smith. (Kegan Paul.)

The Science of the Emotions. By Bhagavan Das, M.A. (Theosophical Publishing Society.) 3s. 6d. net.

The Process Year-Book, 1900. (Penrose.)

Proceedings of the Society for Psychical Research. October, 1900. 6s.

Philips' London School Board Atlas. 1s. net.

Living Races of Mankind. Part III. (Hutchinson.) 7d. net.

Crowhurst's "Chess Board" Astigmatic Test Chart. By H. A. Crowhurst (of Sanders & Crowhurst, 71, Shaftesbury Avenue). 1s. 6d. Published by Newbold & Bulford, 16, Goswell Road.

The Scientific Roll. Bacteria. Vol. I. No. 1. Conducted by Alexander Ramsay, F.I.C. (R. L. Sharland, 38, Churchfield Road, Acton.)

THOMAS HENRY HUXLEY.*

A thousand pages of biography sounds monstrous for an individual share in the story of mankind. But every now and then an actor passes across the stage of human society with so much quicksilver versatility, responsive to so many calls, exciting so much hostility and admiration, taking so large a part in the work, and the thinking, and the fighting, of his time, that every step in his career enchains the interest of a wide circle of readers. When humour and pathos, courage and sagacity, self-denying industry and domestic tenderness, gradually become conspicuous as characteristics of the man's sayings and doings, the long drawn history of his pilgrimage assumes a dramatic fascination. He may still be, as sketched by rumour or by prejudice, the intellectual prize-fighter, the overbearing champion of revolutionary causes. Only, the harsh or rugged outlines of his temperament and activity are no longer repellent in the elaborated portrait. Premature distaste is bound to vanish before the presentment of a man bearing himself with uprightness, fortitude, and delicate sympathy in the everyday romance and the ordinary sufferings of mortal existence; still more when it is found that his position of authority, so far from being extorted by a masterful intellect, [illegible] conceded without grudging to a steadfast character; and, beyond all this, that his whole course was encompassed and comforted by what is hard

* "Life and Letters of Thomas Henry Huxley," by his son, Leonard Huxley. In two volumes. (London: Macmillan & Co., Limited.) 1900.

for an eternally combative man to have, and impossible to be had by a mean man, the constancy and devotion of an incomparable band of friends.

The foregoing remarks are naturally suggested by the "Life and Letters of Thomas Henry Huxley," now given to the world by his son. The volumes might possibly have borne a little compression, a little re-arrangement, a little more considerateness for living relatives of his dead antagonists. But the gaiety of nations will in no way be eclipsed by many of the outspoken judgments, and the cousins of Mr. X. or Mr. Y. may console themselves by observing that their kinsman is in the same boat with Lord Bacon. All these hundreds of pages are of a quality to be read with pleasure. They are of value for example of life and instruction of manners, including, like other books that have been so described, the *exemplum ad vitandum* along with things meet for imitation. There are many essential lessons involved, which haply some may learn to good effect, without knowing that they are being taught.

It cannot be expected that Huxley, followed through the pugnacity of a lifetime, will satisfy every taste or command assent to every opinion in the records of this narrative. That is a fortunate circumstance, perhaps foreseen and rejoiced in by his clever and filial biographer. He is not set before us as the Admirable Crichton of a novel, still less as merely "prig," "savant," or "Gelehrte," wittily assumed by the late Henry Sidgwick to be convertible terms. He is presented to us as a thoroughly human being, fighting at school, joking with middies on board the "Rattlesnake," fancying as a young man (sublimely innocent creature) that he was indifferent to money and fame, owning from first to last that he loved his friends and hated his enemies. Beyond a doubt the high lights of his portrait are relieved by occasional shadows. Of Tennyson he became a stalwart ally and admirer, but at twenty-seven, just after the Duke of Wellington's funeral, he writes to his betrothed, "I send Tennyson's ode by way of packing—it is not worth much more, the only decent passages to my mind being those I have marked." In his table-talk he quotes with evident approval a saying by Sir Henry Holland, "In my opinion Plato was an ass! But don't tell any one I said so!" The world would have suffered no substantial loss if this confidence had not been broken. Gladstone on Gadara he attacked with much controversial success, but he privately owns that his assault was designed to weaken Gladstone's political position. "As to Gladstone and his 'Impregnable Rock,' it wasn't worth attacking them for themselves, but it was most important at that moment to shake him in the minds of sensible men." That way of indirectly undermining an opponent may or may not be decent in the law-courts. It is scarcely a specimen of chivalrous, of Huxleyan, straightforwardness, but rather on a par with the controversial methods of a journalist who vindicates his own judgment on military tactics or the chemistry of the sun by showing that the other man is weak in spelling or faulty in syntax. Huxley was an eminent apostle of education for girls as well as boys, for women as well as men, for teachers as well as the taught, and yet we read (Vol. I., p. 212), of his preparing his "claws and beak" to keep women out of scientific societies, almost as if in 1860 he prophetically sympathized with the Austrian medical students of 1900. He had come to the impolite, may one be permitted to say the unworthy, conclusion, that five-sixths of womankind would never be anything but "intrigues" in politics, and "friponnes" in science. But perhaps in the end he found repentance (*see* Vol. I., p. 417). Wonderfully diversified as his knowledge was, it had its limits, or he could never have written to Kingsley that the Latin affirmation "*Cogito*" was preferable to the English "I think," "because the latter asserts the existence of an Ego—about which the bundle of phenomena at present addressing you knows nothing," though obviously the Ego is just as completely involved in the affix of *Cogito* as it is in the prefix of *I think*. He fancied that "Newton and Cuvier lowered themselves when the one accepted an idle knighthood, and the other became a baron of the empire," not considering that the pride of a cynic may sometimes be seen through the holes of his mantle, and that there may be as much vaingloriousness in refusing a title as in wearing one.

The story of what may be called the Battle of Oxford, in 1860, is here, as it was bound to be, told once more. It is told from the mouth of many witnesses. They are men of veracity and intelligence. They report words publicly spoken, and spoken under circumstances of exceptionally quickened attention, though no doubt also under circumstances of exceptional excitement. The extraordinary upshot is that no one can now be sure of what was really said either by Samuel Wilberforce or by Thomas Huxley. All evolutionists are agreed that Huxley won on that occasion a striking and valuable triumph. But it was almost certainly a triumph of his rhetoric, not his logic, of audacity, not of good taste. The Bishop of Oxford indulged in what he and his party probably deemed innocent and amusing banter. In return that eminent prelate, in the centre of his own diocese, before a throng of those who revered and loved him, was upbraided, according to one unrepudiated account, as a man "who prostituted the gifts of culture and eloquence to the service of prejudice and of falsehood." The absurdity of the thing is transparent when we ask ourselves how long at that date had the scientific world itself been converted to the doctrine of the transmutation of species, how much of it was still unconverted, and for how many years longer did leaders of science hold out against it in France, in Germany, in America, no less than in England. In the companion picture of 1894, again at Oxford, again before the British Association, and once more matched in a conflict of wits with a master of eloquence and sarcasm, Huxley stands forth, as some will think, a second time victorious. But now the triumph is won by refinement of taste, not by bitterness of retort. Put forward to second the vote of thanks for an address, in which the existing state of biological science had been treated with mockery, Huxley knew how to applaud what was laudable in the discourse without approving what was open to debate, and some will remember the dignity of tone and aspect, with which, alluding to his own share in the long Darwinian campaign, he uttered the words, "We of the Old Guard stand firm."

What these volumes tell us of Huxley's researches and his writings, of his innumerable lectures, of his work for societies, associations, congresses, institutions, royal commissions, and popular or unpopular causes, will make some readers wonder how a lifetime could contain it all. No doubt he crowded into his days more than his strength could bear, and had in consequence many penalties to pay, or, to use more strictly philosophical language, what followed, followed. None the less he lived the life of his choice. He won almost every sort of success that is open to such a career. He was always arguing, and always getting the better or the best of the argument. He called himself, it is true, an Agnostic, or Know-nothing, and in that instance for a wonder he was foiled, for he never could persuade the world at large to believe in his total and absolute ignorance. In spite of the hard names by which he was fain to describe his attitude towards all theological dogma, we must remember that he was continually striving after light and truth. The kernel of his religion was this, that men are always working out their own salvation—or the other thing; that we are all hour by hour receiving the rewards and punishments of our own good and evil doings.

But the book itself must be read. It will take many behind the scenes of very unfamiliar playhouses, allowing them to be present at the birth and obsequies of the X Club, to take part in starting the Metaphysical Society, to follow the thread of many a scientific adventure, and, before they have done, they will have realized, if they did not know it already, that Huxley was not only a peculiarly distinguished man of science, but also a preacher of truth and righteousness, and not a preacher only.

WIRELESS TELEGRAPHY. V.

By G. W. de Tunzelmann, B.Sc.

PRACTICAL WORK.

With the exception of the unpublished experiments of Professor Hughes referred to in my last article, nothing seems to have been done in the way of utilising Hertzian electric waves for the purposes of telegraphic communication before the year 1895.

In April of that year, Professor A. Popoff, of the Cronstadt Torpedo School, described to the Russian Physical Society the apparatus shown in Fig. 1, which he employed as a receiver for Hertzian waves. It consisted of a tube coherer built in two sections, and having one of its terminals connected with a vertical wire, and the other with the earth. When a wave fell upon the coherer, causing its resistance to fall from an almost infinite value down to a few hundreds of ohms, a current from the battery was enabled to flow through the circuit and energise the electro-magnet of an ordinary Siemens telegraph relay, thereby closing a circuit, not shown in the illustration, containing a large battery and a telegraphic recorder, which continued in action as long as the current flowed through the battery in the coherer circuit. As soon, however, as coherence was set up, the electro-magnet of the electric bell was energised simultaneously with that of the relay, and the bell hammer striking upon the central plate of the coherer caused decoherence, so that, unless the waves continued and re-established the state of cohesion, the recorder was thrown out of action.

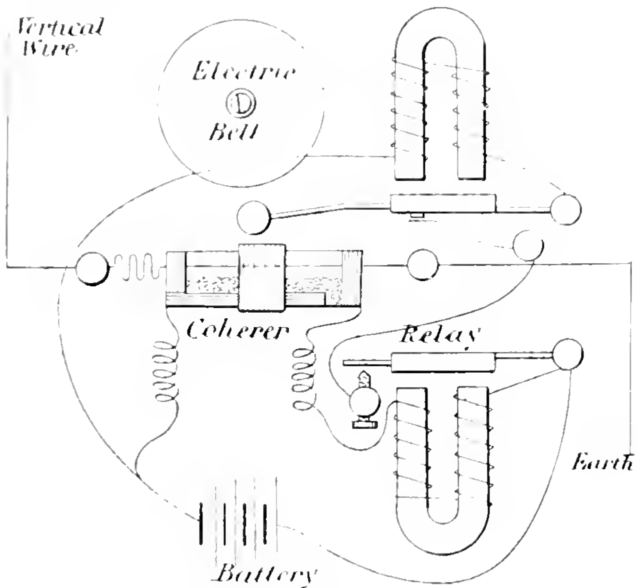


Fig. 1. Popoff's Hertzian Wave Receiver.

Using a Hertz oscillator with 30 centimetre spheres, Popoff was able to send signals over a distance of a kilometre, which he extended to five kilometres, by replacing the Hertz oscillator by a Bjerknes one with spheres 90 centimetres in diameter.

Very shortly afterwards Captain Jackson made some experiments for the Admiralty at Devonport, and succeeded in sending messages from one ship to another. His apparatus, however, and the results obtained with it, were treated as confidential and have not been published.

In June, 1896, Guglielmo Marconi, a young Italian, and a pupil of Professor Righi, applied for provisional protection for "Improvements in transmitting Electrical Impulses and Signals and in Apparatus therefor," and filed a complete specification on the 2nd of March, 1897. At the time of making his provisional application Marconi's apparatus was in a somewhat crude form, but it contained important improvements in details, and in July, 1896, he had the fortune of obtaining the assistance and support of the Postal-Telegraph Department, through the good offices of Sir W. H. Preece, who was then the Chief Engineer of the Post Office.

With this powerful co-operation, combined with his own indefatigable industry and experimental skill, Signor Marconi succeeded in overcoming a host of difficulties, and in developing a commercially practical system of telegraphy based on Hertzian electric waves.

The transmitting apparatus employed for long distances when it is not required to concentrate the waves in a definite direction is shown in Fig. 2.

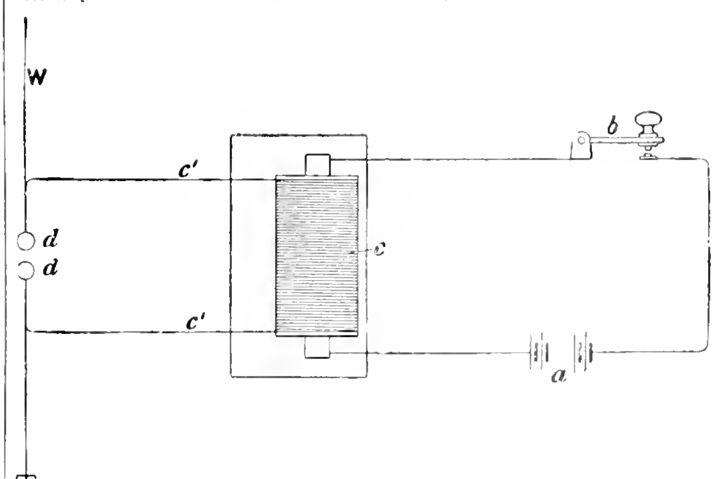


Fig. 2.—Long Distance Marconi Transmitter.

The small spheres, d, d, are connected by the wires, c', c', with the secondary terminals of an induction coil, e, and one of them is also connected with the vertical wire, W, while the other is earth-connected. When the Morse key, b, is depressed, the coil is energised by the battery, a, and therefore, as long as it is kept down, a stream of sparks is maintained between the spheres, d, d.

When it is desired to send a beam of rays in some definite direction, the transmitter used by Marconi is one devised by Professor Righi, of Bologna, and shown in Fig. 3. The two large spheres, e, e, are 11 centimetres

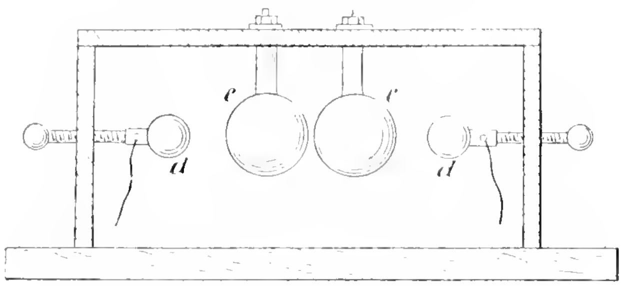


FIG. 3.—Righi Oscillator for use with Reflector.

in diameter, and are separated by a space of a millimetre. In order to concentrate the beam of rays in the required direction the oscillator is placed in the focal line of a parabolic cylindrical reflector, as shown in Fig. 4.

The most important part of the receiver is the coherer, which consists of a small glass tube (Fig. 5), about two and a half millimetres in internal diameter and some four centimetres in length. Two silver pole pieces are lightly fitted into this tube, separated by a gap of about a millimetre, containing a mixture of 96

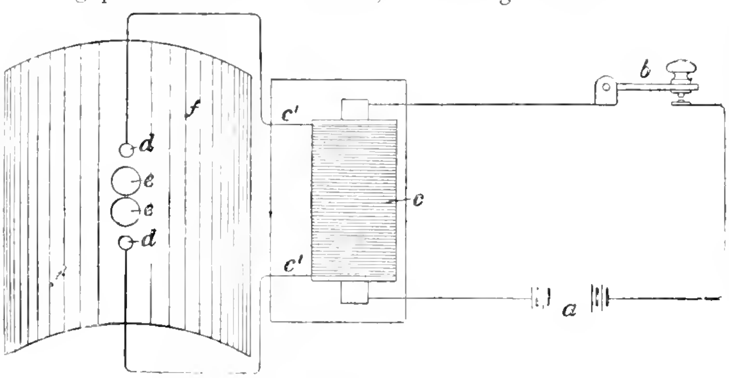


FIG. 4.—Marconi Transmitter with Parabolic Reflector.

parts of nickel and 4 parts of silver, not too finely granulated, and worked up with the merest trace of mercury. This powder must not be packed too tight, or the action will be irregular and over-sensitive to slight outside disturbances, while if too loose it will not be sufficiently sensitive. It

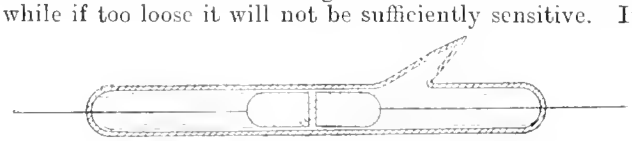


FIG. 5.—Marconi Coherer.

is found that the best adjustment is obtained when the coherer works well under the actions of the sparks from a small electric trembler placed at a distance of about a metre. The tube is then exhausted on a mercury pump until the pressure falls to about a millimetre, when the tubulure left for exhausting it is sealed off. The tubes are tested over a distance of 18 miles before being put into use, and when all the requisite precautions are observed, Signor Marconi finds them as reliable as any other telegraphic instruments, and not liable to get out of order when in use. His experience in this is confirmed by that of Professor Fleming. If the tubes are not exhausted they are found to grow gradually less sensitive, probably from slight oxidation going on, and this of course would not be permissible in commercial instruments.

The general arrangement of the receiving apparatus for long distance work without a reflector is shown in Fig. 6. j, j^3, is the coherer tube, with its silver pole

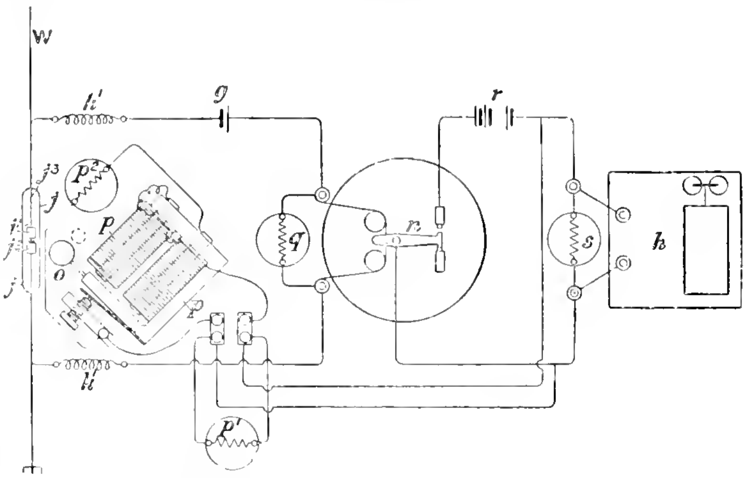


FIG. 6.—Marconi Receiver with Vertical Wire and Earth Connection.

pieces, j^1, j^2. The coherer forms part of a circuit containing a local cell, g, and a sensitive telegraph relay. When electric waves impinge upon the coherer its resistance falls from a nearly infinite value to something between 500 and 100 ohms, which allows the cell, g, to energise the electro-magnet of the relay, n, and close a circuit containing a larger battery, r, together with a Morse recorder, h, and a trembling electric bell, p, to act as decoherer. The hammer, o, of the bell is so adjusted as to tap the coherer tube and shake the filings in it. If at the moment in which these actions took place the electric waves in the resonator had died away, this tap would restore the coherer to its normal condition of practically infinite resistance, and a dot only would be recorded on the tape of the Morse machine. If, however, the key of the transmitter were kept depressed, then waves would succeed each other at very short intervals, so that the acquired conductivity of the coherer would only be momentarily destroyed by the tap of the bell-hammer, and immediately re-established by the electric waves. Now the armature of the Morse recorder is somewhat heavy, and therefore has considerable inertia, so that it cannot follow the very rapid vibrations of the tongue of the relay. The practical result, therefore, is that the Morse instrument gives an exact reproduction of the dots and dashes produced by the movements of the key at the transmitting station, although during each movement of the key, however short, the armatures of the relay and of the tapper go through a series of rapid vibrations dependent on each other.

Small choking coils, k^1, k^1—that is to say, coils wound so as to have self-induction or electric inertia—are introduced between the coherer and the relay, their effect being to compel the greater part of the oscillatory current induced in the circuit by the electric waves to traverse the coherer, instead of wasting the greater portion of its energy in the alternative path afforded by the relay. If these coils are omitted, other circumstances remaining the same, Signor Marconi finds that the distance at which the signals can be distinguished is reduced to nearly half that attained when they are employed.

In order to screen the receiver from the violent surgings which would be set up when using the transmitters at the same station, he enclosed the whole of the receiving apparatus, with the exception of the recorder, in a metallic box. As some of the waves picked up by the recorder would, by travelling along the lead-into the receiver, injure the coherer, he chokes off all such effects by interposing suitable choking coils between the recorder connections and the terminals of the receiver. These choking coils consist of a few turns of insulated wire wound in layers, each layer being separated from the adjacent ones by means of sheets of tinfoil in metallic connection with the enclosing box. This earthed tinfoil prevents the waves from passing inductively from one turn of the choking coil to the next. The earthed terminal of the receiver is connected to the box and need never be touched. Signor Marconi also found that, unless provision was made against it, the relay, the tapper, and the recorder all produced disturbing effects on the receiver, but he got rid of these effects by introducing suitable non-inductive resistances, q, p^2, and s, in parallel with them, or, as telegraphists say, he shunted them with these resistances. This prevented all sparking at the contacts, and sudden perturbations, or jerks, due to the local battery current, all of which would otherwise produce disturbing effects on the coherer.

When it is desired that the receiver should only pick up waves coming in a certain definite direction, the arrangement shown in Fig. 7 is employed. This differs

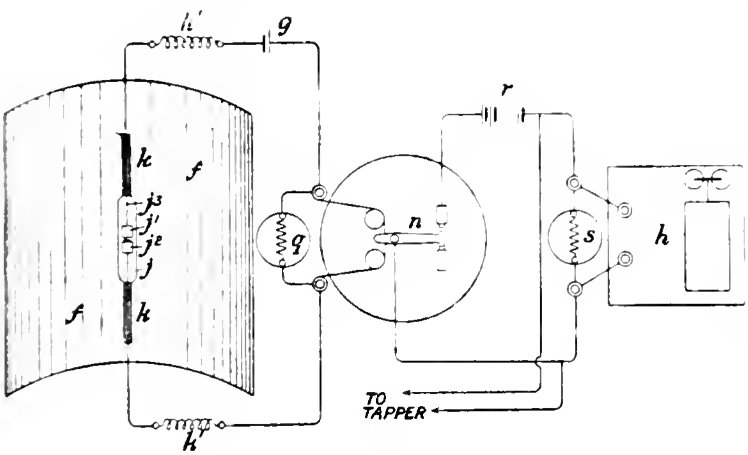


Fig. 7.—Marconi Receiver with Parabolic Reflector.

from that shown in Fig. 6 only in the vertical wire and earth connection being done away with, and replaced by the two copper strips, k, k, the sizes of which must be carefully adjusted so that the receiver may be in syntony with the transmitted waves; and in a parabolic cylindrical reflector being placed so that the coherer tube lies with its axis in its focal line.

My readers will observe the considerable similarity between Marconi's apparatus and that of Popoff; although I believe that, when Signor Marconi designed his apparatus, Popoff's results were unknown to him. Both used the coherer to actuate a relay, and thereby bring into action a telegraph recorder, and both used a tapper to cause decoherence. Popoff also anticipated Marconi in the use of a vertical wire and earth connection on his receiving instrument, but does not seem to have recognised its necessity on the transmitter.

The use of the tall vertical wire on both transmitter and receiver forms one of the most notable of Marconi's improvements, and the one which has perhaps played the largest part in his successful transmission of signals over long distances. A horizontal wire is no use, even if added at the top of a long vertical wire, so as to keep it at a great distance from the earth. The effect of the long wire is to increase the length of the waves generated in the ether, and, therefore, as was pointed out in my first article, to augment their power of penetrating obstacles, the wave length being about four times the length of the wire. The reason that it acts so much better in a vertical position than in any other is that that position is the one which is least favourable to the production of induced oscillating currents in the earth, which, if set up, must dissipate uselessly the amount of energy required to excite them.

Signor Marconi finds that a conductor with considerable capacity, such as a sheet of wire net, attached to the top of the vertical wire by means of an insulating rod, is to some extent equivalent to increasing the length of the wire. He found experimentally that, if the wires at the two stations are equal in height, the distance to which signals could be transmitted was approximately proportional to the square of that height, the actual maximum distance being somewhat in excess of that calculated from this assumption. Professor Ascoli has confirmed this result mathematically.

One of the Marconi masts, 150 feet high, which was erected at the South Foreland last year, is shown in Fig. 8. This mast is now of historic interest, as being the one which was used for the first transmission of messages by the new system of telegraphy between England and France, the French station being at the village of Wimereux, near Boulogne, and at a distance of 32 miles from the South Foreland. In place of using a high mast the vertical wire might, where the opportunity exists, be suspended from the top of a cliff or of a lofty building, and Mr. Marconi has in this way successfully transmitted messages between Bournemouth and Alum Bay in the Isle of Wight, a distance of about 14 miles. No mast was employed at the latter station, the vertical wire being allowed to hang over the edge of the cliff, the instrument and earth connections being at the top, while the lower end of the wire, which was about 100 feet long, hung free in space, the wire being kept at a distance of about 30 feet from the face of the cliff.

I am not aware that any attempts have been made to employ the Marconi apparatus with reflectors for greater distances than two miles. Hertz found that to obtain good results with reflectors they must be large compared with the wave length, and the distance of the mirror from the oscillator must not be less than a quarter of the wave length, as clearly follows from what I explained in my first article, that the emission point of the waves is a quarter of a wave length from the vibrating source.

It will be seen, therefore, that it would hardly be practicable to employ reflectors in conjunction with high masts for transmitting beams of rays in a given direction. For example, with the vertical wire 150 feet long, such as that in use at the South Foreland, the wave length would be about 600 feet. The dimensions of the mirror would therefore have to be large compared with this, and placed at a distance not less than 150 feet from the oscillator.

The use of reflectors is, however, of considerable value for communicating between ships, or ships and the shore, at short distances.

By the use of reflectors it is possible to project the electric waves in an almost parallel beam, which will have no effect upon any receiver not lying in its course, whether this receiver be syntonic with the waves or not. This, as Signor Marconi has pointed out, would enable

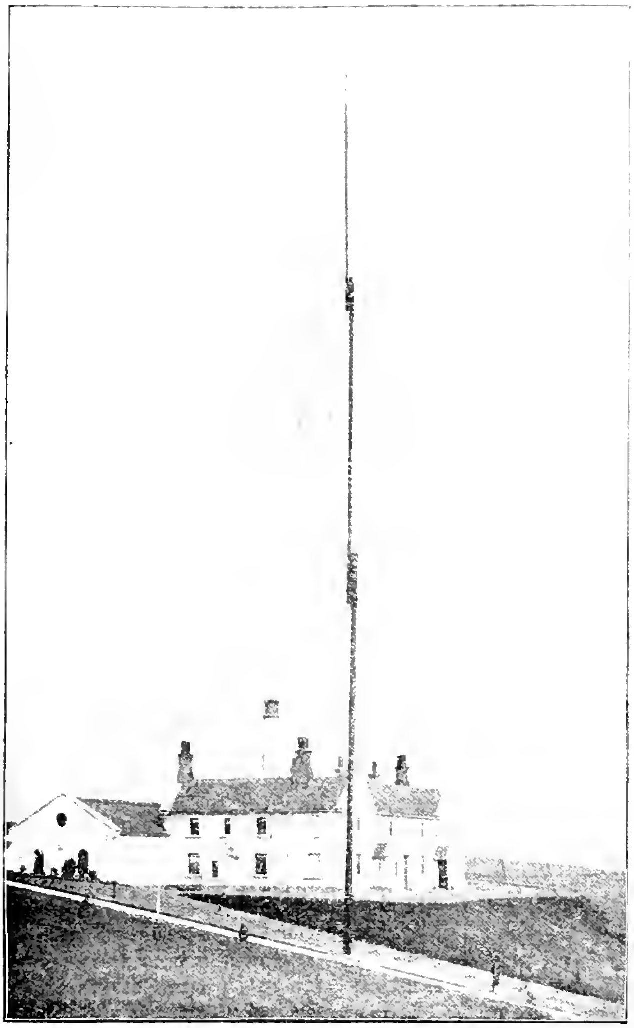


FIG. 8.—Marconi Mast at the South Foreland.

several forts, hill-tops, or islands to communicate with each other in war time, without any fear of the enemy tapping or interfering with the signals, for, if the forts were on a small height, the beams could easily be directed so as to pass over any position that might possibly be occupied by the enemy.

In some experiments, made over a distance of one and three-quarter miles, Signor Marconi observed that quite a small movement of the reflector of the transmitting instrument was sufficient to stop the reception of the signals by the receiver. The zone, within which the receiver had to be placed for a given position of the transmitting reflector, not being more than about 100 feet in breadth.

"There exists," says Signor Marconi, in his paper read in March, 1899, before the Institution of Electrical Engineers, "a most important case to which the reflector system is applicable, namely, to enable ships to be warned by lighthouses, light-vessels or other ships, not only of their proximity to danger, but also of the direction from which the warning comes. If we imagine that A is a lighthouse, provided with a transmitter of electric waves, constantly giving a series of intermittent impulses or flashes, and B a ship provided with a receiving apparatus placed in the focal line of a reflector, it is plain that, when the receiver is within range of the oscillator, the bell will be rung only when the reflector is directed towards the transmitter, and will not ring when the reflector is not directed towards it. If the reflector is caused to revolve by clockwork, or by hand, it will therefore give warning only when occupying a certain section of the circle in which it revolves. It is therefore easy for a ship in a fog to make out the exact direction of the point A, whereby, by the conventional number of taps or rings, she will be able to discern either a dangerous point to be avoided or the port or harbour for which she is endeavouring to steer."

Marconi's apparatus was installed last month on board "The Princess Clementine," one of the Belgian boats carrying on the passenger service between Dover and Ostend. It is stated that the distances covered exceeded eighty miles, and that the apparatus is shortly to be supplied to other vessels belonging to the Belgian Company.

There is a difficulty which will have to be overcome if the system is to come into extensive use, and that is the interference of simultaneous messages coming from different stations, all of which would affect all receivers within range, with the result of making the messages unintelligible.

Professor Lodge has devised and patented some interesting forms of syntonic transmitters, but, as far as I am aware, he has not yet succeeded in transmitting syntonic messages over any considerable distances. A syntonic radiator is necessarily one which produces persistent oscillations instead of having them damped out almost immediately. Now this damping out means that the ether rapidly takes up the vibrations, so that making a radiator syntonic means making it feebler.

It is stated that Signor Marconi has now succeeded in devising apparatus by which syntonic messages have been successfully transmitted to distances of over 30 miles, but as the patents are not yet completed I am not able to obtain any information as to the methods employed.

If he can do this it will prevent the interference above referred to, as the receiver at any station will respond only to the messages intended for it.

Figures 2, 4, 6, 7, and 8 are reproduced by kind permission from Signor Marconi's paper in the "Journal of the Institute of Electrical Engineers," Vol. 28, 1899.

ERRATUM.—Article IV., KNOWLEDGE, October, 1900, p. 235 column 2, line 7, for "10 7 centimetres," read "10^{-7} cm."

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

A convenient means for testing the optical qualities of objectives is very desirable. It is essential that the objects used for this purpose should be most carefully prepared and properly mounted. For low powers the proboscis of the blow-fly is usually recommended; also the scales of butterflies. These objects should appear distinct in detail, flat, and free from marginal colouring. For medium powers stained micrococci, bacteria, and starch grains are useful. For high powers, especially immersion objectives, various diatoms are used, such as *Navicula lyra*, *Pleurosigma angulatum* and *Amphipleura pellucida*.

Those who do not possess a turntable will find a slide centerer an excellent substitute. This piece of apparatus may be readily prepared as follows:—Rule a rectangle the size of an ordinary glass slip on a piece of stout cardboard, draw diagonal lines to locate the centre, and then draw a series of squares and circles about this centre equal to the diameters of the cover-glass most used. This will be found quite as satisfactory as the turn-table for mounting purposes.

Japanese tissue paper used by dentists is excellent for wiping and cleaning lenses, oculars, and objectives.

To examine in the living state small freshwater algæ, protozoa, small crustaceans, hydra, small worms, and other minute plants and animals, they must be mounted in some inert liquid, as water: preferably a drop of the liquid in which the organisms live and grow. Their motion may be reduced by mounting in a solution (10 per cent.) of gum arabic.

Minute objects like diatoms and the scales of insects may be arranged in geometrical figures or in some fanciful way, either for ornament or more satisfactory study. To do this the cover-glass is placed over a guide. The guide for geometrical figures may be a net-micrometer, or a series of concentric circles. In order that the objects may remain in place, however, they must be fastened to the cover-glass. As an adhesive substance, liquid gelatine thinned with an equal volume of 50 per cent. acetic acid answers well. A very thin coating of this is spread on the cover, with a needle or in some other way, and allowed to dry. The objects are then placed on the gelatinized side of the cover and carefully got into position with a mechanical finger made by fastening a cat's whisker to a penholder. After the objects are arranged the operator breathes very gently on the cover-glass to soften the gelatine. On drying the objects will be firmly anchored. In mounting, one may use Canada balsam, or mount in a dry cell.

Shellac cement is a very useful medium for sealing preparations and for making shellac cells. It may be readily prepared by half filling a bottle with scale or bleached shellac, and adding thereto sufficient of 95 per cent. alcohol to fill the bottle. The whole should be shaken occasionally, and allowed to stand until a clear stratum of liquid appears on the top. This supernatant liquid is then filtered through absorbent cotton into an open dish or wide-mouthed bottle. To every 50 c.c. of this filtered shellac, 5 c.c. of castor oil and 5 c.c. of Venetian turpentine are added to render the shellac less brittle. The filtered shellac will be too thin, and must be allowed to evaporate till it is of the consistency of thin syrup. It is then put into a capped bottle and is ready for use.

The examination of living micro-organisms is, as a rule, best carried out by means of the "hanging drop." For this purpose a thick glass slide having a concave well in the middle is made use of. The "hanging drop" is made in the following manner: Place a small drop of water on a clean cover-glass on the table. The drop must be small enough so that it will not run if the cover-glass is placed on edge. The organisms are then placed in the water and a ring of vaseline is placed around the edge of the well on the upper side of the concave slide, by means of a brush or match stick. The slide, with its ring of vaseline, is then inverted over the cover-glass and gently pressed down. The cover-glass now adheres to the slide, which is then inverted. Care should be taken to see that the ring of vaseline is continuous around the edge of the well. If such is the case no evaporation of the drop of water can take place, and hence the hanging drop can be examined at leisure and without the presence of annoying currents in the liquid.

A great variety of bacteria, moulds and yeasts can be obtained by the student of bacteriology from the air. The following simple procedure, suggested by Dr. F. Nory, will enable anyone to grow these bacteria from the air, and thus obtain a variety of organisms suitable for examination in the living condition and for staining purposes. Place two or three sound potatoes and a knife in a vessel of water and boil for twenty minutes. Pour away the water, and, when cool, cut them in halves with the sterilized knife, taking care to touch neither the blade nor the potatoes with anything. Transfer the potatoes, cut side uppermost, to a piece of paper, and leave them exposed for from ten to thirty minutes. Then cover them with a glass tumbler, and at the end of about forty-eight hours they will begin to show one or more pinhead growths. These growths are due to organisms, which, floating about in the air, have dropped on the potatoes and have there found a soil congenial to their growth.

The germination of seeds in sterilized water to which varying quantities of oxygen had been added has been studied by M. P. Maze. He concludes that, while life appears to remain latent, certain slow changes take place, although germination under water may fail on account of lack of aeration. Some small seeds are developed slowly by the atmosphere within their coats. Starchy seeds under water quickly lose all power of germinating, oily seeds retain it longer; but there is no proof that any seeds can long retain their vitality. The weakening of the submerged embryos is attributed to the accumulation of poisonous products, especially aldehyde.

Messrs. R. and J. Beck have placed on the market a new microscope on the "Continental" model which they call the "London." Many improvements have been introduced in matters of detail which make it worthy of notice. The workmanship is in Messrs. Beck's best style, and the price reasonable for a first-class instrument.

NOTES ON COMETS AND METEORS.

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

BRORSEN'S COMET. The return of this interesting short-period comet is expected early in 1901, and a sweeping ephemeris has been published in *Ast. Nach.*, 3670, by A. Berberich, of Berlin. From this it appears that the comet is now invisible in English skies owing to its southern declination, but that it is travelling northwards and ought to be favourably presented to view at the end of January and in February, 1901. Berberich's ephemeris is for Berlin midnight, and the positions at eight-day intervals are:—

Date.			R.A. H.	R.A. M.	Dec. °	Dec. ′	Distance of Comet in Millions of Miles.
1900.	December	17	22	8	−44	32	62
	,,	25	21	59	39	46	56
1901	January	2	21	39	33	4	47
	,,	10	21	9	22	54	40
	,,	18	20	8	−9	37	38

The path is from Grus through Piscis Australis and Capricornus, after which it passes through Aquila. It will be nearest to the earth at the middle of January, but at that time will be too near the sun for observation. Soon afterwards the comet ought to become visible just before sunrise low in the east. This comet was discovered in 1846, and it has a period of revolution of about 5½ years. It was last seen in 1879, and should have returned in 1884, 1890, and 1895, but escaped detection. It is now questionable whether the comet exists in the same form and dimensions as in 1879 and previous years. The supposition is that, like Biela's double comet, it is practically lost to us as an observable object. But it remains to be seen whether the large telescopes of the present day are capable of redetecting the comet, for they will sure to be employed in the search during the months of Janurary and Februrary next.

COMET BORRELLY BROOKS. This object is now exceedingly faint, but its position is very favourable. It was observed by Dr. Schorr at Hamburg on October 16th, and may possibly be picked up in December in a good instrument. The following places are by Wedemeyer (*Ast. Nach.*, 3670):—

Ephemeris for Berlin Midnight.

Date. 1900.		R.A. H.	R.A. M.	R.A. S.	Dec. °	Dec. ′	Dec. ″	Distance in Millions of Miles.
December	10	16	19	17	+71	52	56	175
,,	14	16	26	54	+73	0	30	181
	18	16	34	55	+74	12	31	184
	22	16	43	25	+75	28	15	187
	26	16	52	33	+76	48	38	190
1901.								
January	6	17	23	15	+80	13	6	198

The comet is thus moving slowly to N.N.E. amongst the stars in Ursa Minor.

BARNARD'S COMET (1884 II.). This object escaped observation at its last two returns, and there seems a very meagre prospect of it being seen at the present time owing to generally unfavourable conditions. Its computed position on December 26 is R.A. 20h. 14m., Dec. −22° 5′.

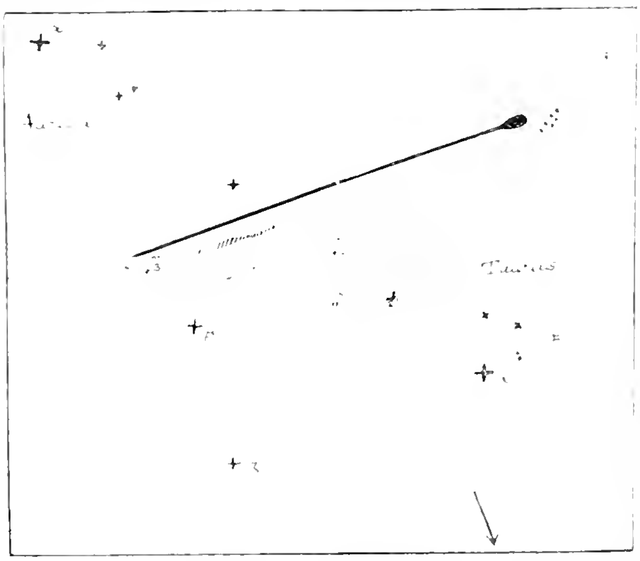
FIREBALL OF SUNDAY, OCTOBER 21, 8H. 35M. A magnificent slow moving fireball was observed from all parts of England. The sky was clear over the country, and as the meteor travelled leisurely along its course from S.W. to N.E. there occurred three explosions or outbursts, and these induced very vivid lightning like flashes. At Tewkesbury the meteor is said to have given a momentary flood of brilliant moonlight, and about three minutes later there was a detonation like that produced by the firing of a heavy gun at a great distance.

Mr. Ballard, of Leigh Linton, near Malvern, says that the meteor fell within ten yards of his house. It appeared just over him, and he moved to be out of its way when it fell just over the hedge. The Rev. H. J. Scott, writing from Clun, Shropshire, says that three minutes after the meteor had disappeared he heard a sound like the distant but distant roll of artillery for 15 or 20 seconds. Another observer at C—, says the meteor passed overhead, and that two minutes later he heard a rumbling sound resembling distant thunder. As the nucleus sailed along several variously coloured fragments detached themselves from it. At Devizes some observers counted seven of these smaller bodies, and say that the phenomenon ended in a shower of sparks followed by the sound of a gun. A considerable number of descriptions have appeared in the newspapers but they are very incomplete and in some instances inaccurate. Hence it is extremely difficult to deduce a satisfactory real path, but it certainly appears that the object was very low in the air. From some of the most reliable accounts it would seem that the radiant was in Sagitta at 300° + 22°, and that the meteor passed from a height of 68 miles over a point near New Radnor to a height of 20 miles over Shiffnal. Length of path 66 miles, and velocity 11 miles per second. The fireball was certainly a splendid object, but it is questionable whether it justified the *Daily Mail's* expression that it was "one of the brightest meteors seen in an English sky for many a year!" About 10 minutes after the fireball had appeared, another and a smaller one was seen moving in a contrary direction, and at 9h. 25m. a third appeared. There was also a bright meteor at about 10h., and at 11h. 58m. Prof. A. S. Herschel recorded one equal to Venus falling slowly from 149° + 46° to 155° + 38° and leaving a train of orange sparks. The latter was also seen by Mr. C. L. Brook, at Meltham, near Huddersfield. The radiant was at 350° − 4°, and height of the object 63 to 48 miles over the North Sea.

OBSERVATIONS OF SHOOTING STARS IN OCTOBER.—The month was tolerably favourable, and at Bristol 141 meteors were observed in $12\frac{3}{4}$ hours' watching. The radiants well determined were as follows:—

Date.	Radiant.	No. of Meteors.	Appearance.
October 23—27	99 + 13	10	Rapid streaks.
,, 23	92 + 15	5	Rapid streaks. Orionids.
,, 26—27	91 + 16	5	,, ,, ,,
,, 23—27	43 + 12	8	Rapid. White.
,, 23—27	45 + 27	8	,, ,,
,, 23—27	57 + 9	6	Rather swift.
,, 23—27	47 + 43	6	Slowish.
,, 26—27	123 + 42	4	Rapid streaks.

FIREBALL OF OCTOBER 27, 11H. 42M.—The writer at Bristol saw a meteor several times brighter than Venus, shooting rapidly from 79° − 33° to 56° + $24\frac{1}{4}$°. It left a bright irregular streak, a section of which was watched with a small opera-glass, power 2, for 13 minutes. During this period it drifted 17 degrees in a southerly direction. Soon after its first projection it formed a perfect sickle, the denser and more enduring section forming the handle. The meteor was observed by Mrs. W. H. S. Monck, of Dublin, passing just below the belt of Orion in a direction from east to west. The meteor had a radiant at 136° + 34°, and its height was from 76 miles over a point 5 miles W. of Basingstoke to 67 miles over a point 8 miles S. of Salisbury. Observed path 34 miles, and velocity about 40 miles per second, the duration of flight being estimated 0·9 second.



Path and Streak of Fireball of 1900, October 27, 11h. 42m., observed by W. F. Denning, at Bristol.

THE LEONIDS OF 1900.—At Bristol the weather was unfavourable on November 13th and 14th, but occasional observations showed that Leonids were very scarce. There were a few brilliant slow-moving Taurids from a radiant at 58° + 10°.

THE FACE OF THE SKY FOR DECEMBER.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 7.45 and sets at 3.54; on the 31st he rises at 8.8 and sets at 3.58. He enters Capricornus, and Winter commences on the 22nd at 7 A.M. Few sunspots are to be expected.

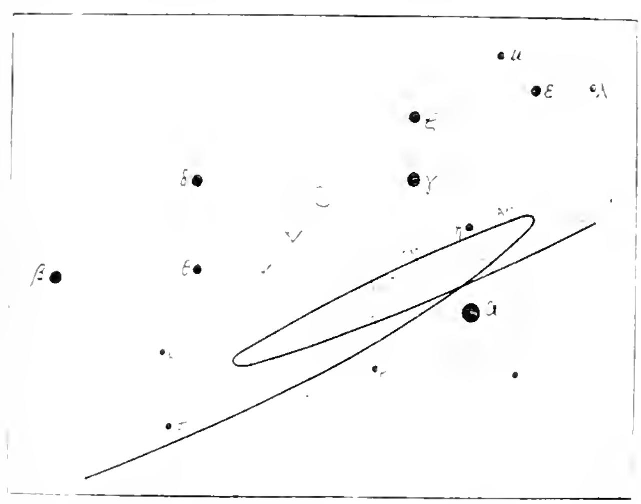
THE MOON.—The moon will be full on the 6th at 10.38 A.M., will enter last quarter on the 13th at 10.42 P.M., will be new on the 22nd at 0.1 A.M., and will enter first quarter on the 29th at 1.48 A.M. The more interesting occultations during the month are as follows:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Dec. 3	19 Arietis	6·2	5 7 P.M.	31	70	5.55	287	323	11 11
,, 5	ω^2 Tauri	4·6	6 11 P.M.	26	67	6.46	312	353	13 11
,, 10	κ Cancri	5·0	8.56 P.M.	111	148	9.52	278	317	18 14
,, 26	51 Aquarii	5·8	7 42 P.M.	29	356	8.33	280	244	4 20

THE PLANETS.—Mercury is a morning star, reaching the greatest westerly elongation of 20° 50′ on the 8th. On the 3rd he rises at 5.50 A.M., and on the 10th at 5.58 A.M., so that his position may be considered fairly favourable, especially as there are no bright stars or planets in the neighbourhood.

Venus is a morning star, rising shortly after 4 A.M. on the 1st, and at about quarter to 6 on the 31st. On the 15th the illuminated portion of the disc is 0·836, and the apparent diameter 12·8″.

Mars is visible before midnight throughout the month, rising on the 1st at 10.35 P.M., and on the 31st at 9 21 P.M. The path of the planet is easterly through Leo (see diagram). On the 15th, the illuminated part of the disc is 0·907, the apparent diameter 8·6″, and the distance from the earth about 100 millions of miles.



The apparent Path of Mars, from November 1, 1900, to July 1, 1901.

Eros, which is now receiving so much attention in a new determination of the solar parallax, may be observed throughout the night. The following is an abridged ephemeris, for Berlin midnight:

	Right Ascension			Declination	
	H.	M.	S.	°	′
December 1	1	27	29	+50	23.8
" 6	1	26	39	48	40.0
" 11	1	28	44	46	45.7
" 16	1	33	26	44	41.3
" 21	1	40	36	42	38.3
" 26	1	50	1	40	30.0
" 31	2	1	23	38	21.0

The planet is nearest to the earth on December 26th, when its distance is 0.3148 that of the Sun, and its parallax estimated at about 28″. The planet may be distinguished from neighbouring stars by its relative motion, which is very rapid; its apparent stellar magnitude will be about 9.0.

Jupiter, Saturn and Uranus are too near the Sun to be observed, being in conjunction on the 14th, 29th, and 5th respectively.

Neptune is in opposition on the 20th, and may be observed throughout the night. During the month he describes a short westerly path in the most eastern part of Taurus, but as it lies in the Milky Way, careful observation will be required to identify the planet. The path is a little to the south of a line joining η Geminorum and 132 Tauri, at nearly equal distances from the two stars.

The Stars.—About 9 p.m. at the middle of the month, Cancer, Gemini, and Canis Minor will be towards the east; Auriga high up towards the east; Taurus and Orion towards the south-east; Perseus and Cassiopeia nearly overhead; Aries and the head of Cetus in the south; Andromeda high up towards the north-west; Pegasus a little south of west; Cygnus and Lyra in the north-west; and Ursa Major a little east of north.

Minima of Algol at convenient hours occur on the 14th at 9.25 p.m., and on the 17th at 6.14 p.m.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of November Problems.

(P. G. L. F.)

No. 1.

1. R to KR3, and mates next move.

No. 2.

Key move—1. Q to Rsq.

If 1. . . . P to K5,	2. Q to KR8ch.
1. . . . B × P,	2. K × B.
1. . . . Any other,	2. Q × Bch.

Correct Solutions of both problems received from Alpha, W. de P. Crousaz, G. A. Forde (Capt.), H. S. Brandreth, Major Nangle, and one unsigned from Bradford.

Of No. 1 only from W. F. Preedy, H. Le Jeune.

H. Le Jeune.—QKsq would be met by . . . PK5.

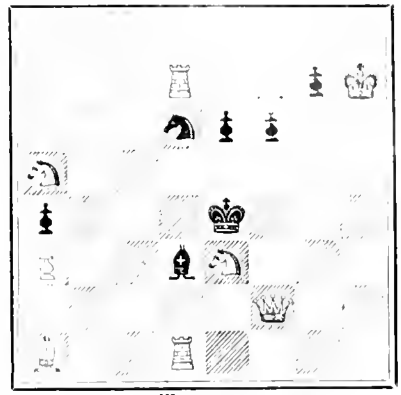
P. A. Cobbold (Ontario).—Your solution of No. 1 (October) is correct, but K to B2 will not solve No. 2, BB5 being a valid defence. In the variation you give (2. QB6ch, K × P) there is nothing approaching a mate.

PROBLEMS.

No. 1.

By Jeff Allen (Calcutta).

Black (7).



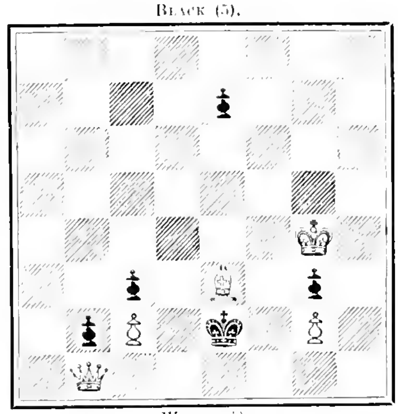
White (9).

White mates in two moves.

No. 2.

By Major Nangle.

Black (5).



White (5).

White mates in three moves.

CHESS INTELLIGENCE.

"Knowledge" Solution Tourney.

A Solution Tourney is to be started in Knowledge, in the January number of the journal. The sum of One Guinea is offered as First Prize, and Knowledge free for twelve months as Second Prize. The conditions are as follows:—

1. The Tournament will begin on January 1st, 1901, and will include all the direct mates in two and three moves printed in Knowledge during the year 1901.
2. If a Problem be incorrectly printed it will be cancelled and reprinted.
3. Key-moves only need be given. A correct key to a two-move Problem will score two points, to a three-move Problem, three points. A *second* solution will score one point. An incorrect claim for a second solution will lose one point. If a Problem has no solution, the fact must be stated; it will then count as a correct key.
4. In the event of a tie for either prize, the Chess Editor may decide it by a further trial of skill under new conditions.

5. Solutions must bear postmark not later than the 10th of the month of publication.

The British Chess Company (Stroud, Gloucester) have brought out a miniature chess-board, on the *In statu quo* principle. It consists of a neat, strong cardboard box ($5\frac{1}{2} \times 4 \times \frac{1}{2}$ inch). Fixed to the bottom of the box is a chess board drilled with holes, extra holes being provided for the captured men. The men are ebony and box wood, with pegs to fit into the holes. The price for one set is 2s. 6d., for three sets 6s. 9d., and for six 12s. Altogether it is a very neat and useful contrivance.

The following characteristic game was played by Mr. Steinitz in the Vienna Tournament of 1882. In that tournament he divided the first and second prizes with Herr Winawer. The notes are from Knowledge of that year.

French Defence.

White. W. Steinitz.	Black. B. Fleissig.
1. P to K4	1. P to K3
2. P to K5 (*a*)	2. P to Q4
3. P × P *en pass.*	3. B × P (*b*)
4. P to Q4	4. Kt to K2
5. B to Q3	5. Kt to Kt3 (*c*)
6. Kt to KB3	6. Kt to B3
7. Kt to B3	7. Kt to Kt5 (*d*)
8. BQ to B4	8. P to QB3
9. Kt to K4 (*e*)	9. B to B2
10. Castles	10. Castles
11. R to K	11. Kt to Q4
12. Kt to B5	12. Kt to R5
13. Kt to K5	13. Kt to B4 (*f*)
14. PQ to B3	14. B × Kt
15. R × B	15. Kt to B3
16. R to Ksq. (A)	16. P to KR3
17. Q to B3 (*g*)	17. Kt to Q4
18. B to Kt3	18. P to QKt3 (*h*)
19. Kt to Q3	19. B to R3
20. Kt to K5	20. R to Bsq
21. B to B2	21. Kt (B4) to K2
22. Q to Kt3	22. K to Rsq
23. Q to R4	23. K to Ktsq (*i*)
24. Q to Kt3	24. K to Rsq
25. Q to R3	25. Kt to Ktsq
26. Q to R5	26. R to B2
27. B to Q2 (*j*)	27. QKt to B3
28. Q to R3	28. Kt to Q4 (*k*)
29. P to QB4	29. QKt to B3
30. QR to Qsq (*l*)	30. Q to Ksq (*m*)
31. B to B4 (*n*)	31. R to Bsq (*o*)
32. Q to R3 (*p*)	32. B to Kt2
33. Q × P	33. B to Rsq
34. Q × KtP	34. P to Kt4
35. B to Kt3	35. Kt to Q2
36. Q to Kt3	36. P to KB4
37. P to B3	37. K to Kt2
38. P to B5 (*q*)	38. QKt to B3
39. Kt to B4	Resigns (*r*)

Notes.

(*a*) Not usually played. The object is to confine the Queen's Bishop, and hamper Black's game.

(*b*) Perhaps to be preferred to P × P, as the two Pawns on the Queen's side would, at a later stage of the game, be subjected to attack.

(*c*) With a view of eventually playing P to K4.

(*d*) Black was afraid of Castling, on account of the commanding position of White's Bishop; for after Castles, White might at once proceed with P to KR4, Kt to Kt5, P to R5; that is to say, proceed upon the basis of attacking the Pawn at R2, of which we indicated the general lines; therefore Black wished to exchange that Bishop.

(*e*) This again places another piece in a favourable position; should Black play P to KB4, then his King's Pawn becomes weak, because unsupported by another Pawn, and therefore more liable to capture.

(*f*) All this is merely wrangling for good position, but Black is wasting time in trying to exchange pieces.

(A) QB3 might be played at once. For if Black replies Kt to Q2, then Kt × KP.—(C. D. L.)

(*g*) This is Mr. Steinitz's old style; Black cannot move P to QKt3 now, even if he wished to do so, he suffers from the inconvenience of having his Bishop blocked in.

(*h*) We shall see later on how the Pawn on B3 will fare.

(*i*) Black would be satisfied with a draw.

(*j*) Inch by inch the ground is won; this is a fine move. He intends at the suitable moment to push on his QBP and use the Bishop for attacking on the Queen's side, *via* Kt4.

(*k*) Playing into White's hands; the difficulty is, what to do? He dare not move the King's Knight, as White would play B × RP. Had Black played Kt to Q2, White might have responded with Kt to Kt4, threatening the dangerous Kt × RP, which would yield White a winning attack.

(*l*) White is in no hurry; he goes steady but sure. This move will further aid White, as the Black QBP cannot be now advanced.

(*m*) With the object of avoiding a discovered attack on his Queen, but it cramps his pieces very much.

(*n*) White changes the originally intended move, for if he had played B to Kt4, P to B4, etc.

(*o*) R to K2 was the only other move. Black's Rook is brought into awkward play, on account of the necessity of defending QBP, showing plainly how a strong player will take advantage of even a very slight weakness.

(*p*) White pressed on in sometimes an almost imperceptible manner, and now he has gained the desired opportunity. He wins two Pawns and the game, he having by sheer good judgment outmanœuvred his opponent.

(*q*) A fine move. It further tightens his already strong hold. He intends playing his Kt to Q6.

(*r*) Black simply has no good move; he is crushed. If R to Ksq, then B × BP. White also threatens to win by Kt to Q6. If Q to Qsq, then of course R × P.