SIMPLY WORDED—EXACTLY DESCRIBED.

AN

ILLUSTRATED MAGAZINE
OF
SCIENCE LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

"Let Knowledge grow from more to more."
TENNYSON

VOLUME XXIV.

JANUARY TO DECEMBER, 1901.

London:
KNOWLEDGE OFFICE, 326, HIGH HOLBORN, W.C.

LONDON
PRINTED AT KNOWLEDGE OFFICE, 326, HIGH HOLBORN, W.C.

INDEX.

INDEX OF THE PRINCIPAL ILLUSTRATIONS.

KNOWLEDGE
AN
ILLUSTRATED MAGAZINE
OF
SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR

LONDON: JANUARY 1, 1901.

CONTENTS.

THE SIZE OF OCEAN WAVES.

By VAUGHAN CORNISH, M.SC.(VICT.), F.C.S., F.R.G.S.,
Associate of the Owens College.

"The heights of waves and their velocity are subjects on which observations are never amiss."—*Vide Admiralty Manual of Scientific Enquiry.*

OF all the phenomena of our physical environment what is so fascinating yet elusive as a wave! Since the earliest days the voyager returned has told about the waves he met, and their bigness, yet even now we cannot get an answer which shall be at once short, clear, and accurate to the question—what is the size of the waves in a storm at sea? I propose in these articles to describe in some detail what has been done towards answering this question, which, as I know from my personal experience, excites a wide interest. I seek, not to satisfy, but to stimulate this interest, and to enlist more observers, particularly among those whose opportunities permit of continuous and systematic observations. Most to be desired are observations from on board ship, in deep water far from land, but observation from the sea shore would also be welcome, and those from lightships and lighthouses exposed to the waves would be distinctly valuable.

Observations of the large waves which disturb the surface without affecting the bottom of the deep sea can only be made from on board ship, and are extremely difficult to carry out. Not only are the phenomena more complicated than in shallow water, where some regularity of direction and of speed is imposed by the limitations of depth, but the conditions on a ship are themselves unfavourable for this class of observations. The principal things to be observed are the difference of level between crest and trough, or the height of the waves, the distance from crest to crest, or the wave length, and the rate at which the crests or ridges travel, the velocity of the wave, and the interval of time between the arrival of the ridges, *i.e.*, the period of the wave. The height of the waves would be less difficult to determine if the ship herself did not rise and fall, or if she floated as a cork, but in practice she does neither the one nor the other, and the difference between the rise and fall of the centre of gravity of the ship and the rise and fall of the water cannot be calculated theoretically. Moreover, the observer cannot watch the waves from the centre of gravity of the ship, but has to station himself where the level of his eye is also continually being altered by the rolling, and sometimes by pitching. The eye under these conditions loses its power of judging horizontality owing to the sudden tilts which change the apparent direction of gravity. The length between succeeding ridges is less difficult to observe, for the known dimensions of the ship give a ready means of measurement; or a buoy can be towed astern at the end of a line of known length. Frequently the length from ridge to ridge varies greatly (sometimes in the proportion of 1 to 2, or even 3) for succeeding ridges. We have in such cases to do with more than one set of waves, for the length should vary very slightly for succeeding waves of a single set; the observed distances from ridge to ridge are, therefore, frequently, not wave lengths at all in the physical sense, but casual intervals, the dimensions of which do not enable us to calculate the velocity of the ridges by means of the theory of waves. The velocities of the ridges must, therefore, be directly measured, which can be done by timing the passage of a wave from bow to stern or from stern to bow, making the necessary allowance for the speed of the ship and the angle between her course and that of the waves. An accurate determination even of the time of passing the length of the vessel is not easy for a single observer, and the want of concordance between the ship's course and that of the wave often makes accurate measurements of velocity impossible. The best plan no doubt would be to stop the ship, but as traffic becomes more and more concentrated in big, fast vessels, the difficulty of making the necessary arrangements is correspondingly increased. In the case of the liners by which most of us now travel, the waves made by the ship herself interfere with the observation of any but large waves.

The finest attempt yet made to carry out systematic observations of waves at sea was that of the late Lieutenant Paris, of the French Navy; a pretty full account of whose work follows, condensed from the original paper in the *Revue Maritime et Coloniale*, Vol. XXXI., 1871, a publication little known to the majority of scientific men in England, and not very easy of access. Next, for comparison, I give a shorter account of the observations made on the French ship *Astrolabe*, from the original paper in the *Comptes Rendus* of the Paris Academy of Science; and, thirdly, a summary of an important paper in the *Philosophical Magazine*, for April, 1888, in which the Hon. Ralph Abercromby described his attempts to impart a higher degree of accuracy to wave measurement. After these summaries of important papers I shall resume a more general treatment of the subject. Lieutenant Paris' observations of waves were conducted on board the *Dupleix* and *Minerve* during the years 1867-70 in the Atlantic, Indian, and Pacific oceans, and in the Japan and China seas. Observations were made in the open sea on 205 days. Of these 29 were days on which the sea was practically smooth. On the remaining 176 days the heights of the waves were measured, but the determinations of wave length and velocity were only made in 109 days, there being 67 days during which the divergence between the ship's course and that of the waves prevented accurate observation of length and speed. When the divergence exceeded 45 degrees observation was useless. About 4000 waves in all were measured. The speed was obtained by recording, with a watch having a seconds' hand, the time the wave crest took to traverse the length of the ship, and applying the necessary correction for the speed of the vessel. The interval of time between the arrival of succeeding wave crests was also taken, and this, combined with the determination of speed, gives the wave length or distance from crest to crest. We have then determined by actual observation the speed, periodic time, and length of the waves without having recourse to the theoretical calculation of one or two of these values from the observed value of the other. This is rather important, because without a more elaborate investigation than is usually given we cannot be certain that we are dealing with a single series of waves, and the ordinary formula of reduction from period to length, from speed to length, and from period to speed, is based on this assumption. The values which Lieutenant Paris endeavoured to obtain were not so much the dimensions of single waves as the average dimensions of a number of waves passing the ship during a selected time of observation on each day. The occasion chosen for observation appears to have been not a fixed time of the day, but one selected for the state of the sea, the object being to secure as far as possible that the waves should have grown to their maximum dimensions under the breeze. The recorded speed or length of waves for any one day is the mean of at least 10, sometimes as many as 50 waves, and each of these means is treated as a single measurement. When for instance we find recorded that the maximum wave length observed in the Southern Indian Ocean was 235 mètres (771 feet), this implies that 771 feet was the greatest average wave length observed on any one day, not that it was the greatest distance which separated any two succeeding wave crests.

The height of the waves from trough to crest was estimated as follows:—The observer established himself where he could get the crest of the waves passing near the ship on a level with the horizon when he was himself above the trough of a wave. In a comparatively smooth sea the position of the observer was at one of the lower port holes, in a rough sea he would mount the shrouds. Then, says Paris, the height or amplitude of the wave is easily determined, for it is equal to that of the eye above the flotation line when the ship is on an even keel. This latter height being known, need not, he says, be determined afresh at each observation.

This assumes that the draught of the ship in the trough of the waves is constant, and equal to the draught in smooth water, which, however, is not the case. Lieut. Paris may either have overlooked the fact or may have decided to neglect the correction. There are various means of checking these measurements of waves which were applied when circumstances permitted, and when practice had been attained Lieut. Paris reckoned his measurements to be good to about 10 per cent., one-tenth part of the whole.

The strength of the wind was also recorded at the time when the waves were observed. Strictly speaking, one should know also how long this wind has been blowing, but that is hardly practicable with a ship on its course except perhaps in the Trades. The strength of the wind may be measured either by the pressure which it exerts or by its velocity. Paris chose the former method, and constructed an apparatus which measured the effective pressure of the wind upon a thin rectangular plate. In order to connect the pressures registered by the instrument with the velocity of the wind, observations were taken at favourable opportunities of the time required for light bodies tossed off from the cross-trees to fly the length of the ship. The values thus obtained for the connection between pressure and velocity are recorded in the subjoined table. The numbers in the first column of Table I. are those by

Table I.

Wind velocity and pressure according to Lieut. Paris.

Numbers recorded in the Log.	Verbal Description.	Velocity in Feet per Second.
0	Calme	0·0
1	Presque calme	2·63
2	Faible brise	3·87
3	Legère brise	4·76
4	Petite brise	13·94
5	Jolie brise	34·12
6	Bonne brise	67·92
7	Vent frais	128·6
8	Vent grand frais	201·1
9	Coup de vent	354·3
10	Tempete	607·0
11	Ouragan	820·2

which the strength of the wind is usually recorded when the record depends solely on the estimate formed by the observer without use of instruments. These numbers are roughly proportioned to the square root of the velocity.

It was in the southern Indian Ocean between the Cape of Good Hope and the Isles of St. Paul and Amsterdam, in the region of almost continual westerly winds, that the largest waves were observed. On the 25th October, 1867, during a gale from the N.W., with violent snow squalls, thirty waves were measured at different times of the day which averaged 29.53 feet (9 mètres) in height. The largest of them were 37.53 feet (11 mètres) in height, and of these no fewer than six in succession were observed, which followed one another with admirable regularity. They lifted the corvette as if it had been a whaleboat, then left her wallowing in a deep trough, extending far on either hand. Paris had to mount to the 22nd rung of the shrouds before he attained the level of the crest. On the evening of the same day waves even larger were seen but not measured. Those on board the corvette seem to have agreed that the waves of this 25th October were the largest within their experience. The height of the individual waves was often found to vary in the proportion of 1 to 2; it was only in very favourable conditions that the average height was 0·7 or 0·8 of the extreme height. In the open ocean a strong wind soon caused waves of as much as 16·4 feet (5 mètres).

The distance from crest to crest was found often to vary in the proportion of 1 to 3 in two successive waves. In a rising sea the wave length increased more rapidly than the height, a process which was found to continue for several days. Thus, to the east of the Cape of Good Hope, during strong west winds, which blew with great regularity for four days, the height of the waves only increased from 19·69 to 22·97 feet (6·7 mètres), whilst the length which was but 370·74 feet (113 mètres) on the first day had attained 771 feet (235 mètres) on the fourth. This was the greatest daily average length observed, but individual cases occurred in which more than 1312 feet (400 mètres) separated two succeeding ridges, and an interval of 984 feet (300 mètres) was not uncommon.

Much interest attaches to the determination of the ratio of the length to the height of waves. The minimum observed by Paris, for a train of waves presumably, was 13, but this was among the Kuriles in a cross sea near to land, and with strong currents running. This observation is therefore not strictly one of ocean waves. In the open ocean with a "moderate breeze" of 16.8 knots (geographical miles per hour) the length was about 25 times the height, in a gale the ratio is as low as 18, and in a labouring cross sea the ratio does not generally exceed 20. When the wind drops, the waves, of course, flatten out: when the length has become 40 times the height the condition is that of a "long swell."

The velocity, according to Paris, is the least variable element. When the breeze had been blowing steadily for some time and the sea was regular, the velocity varied but little from one wave to the next. In fact, he says, it is a rare thing in the open ocean to see two large waves pass one over another, which would be occurring every moment if there were the smallest difference in their velocities. We shall see later on that another good observer, the Hon. Ralph Abercromby, had quite different experiences on this point. In the open ocean, sufficient depth is pre-supposed; Paris finds from his daily record that a wind of the same force gives everywhere almost the same velocity of wave. He does not consider himself to be "*au large*," unless he is at a distance from the windward shore of at least twenty leagues; only then, he says, can the waves attain their full development.

The following observations were made upon the persistence of the swell after the cessation of wind. Having left the strong breezes or gales from the S.W. on October 31st, 1867, for the calm of the tropic of Capricorn, the ship, now under steam, was accompanied for three days by a swell unruffled by the slightest breath of wind. The S.W. winds had raised regular waves 14.77 feet (4.5 mètres) high, and 469 feet (143 mètres) average length, with a velocity of about 30 knots; sixty hours later, the distance traversed being 350 miles, the velocity of the wave had only diminished 2 per cent., about 0.6 knot, the wave length being 443 feet (135 mètres). The difference between the lengths of successive waves seems to have remained large. During this period the height of the waves had diminished by one half. Such a swell, if there be a sufficient stretch of open sea, would finally become invisible owing to this flattening out of the wave, for waves are only seen by difference of illumination of their front and back, but in this particular case the observer lost sight of the swell long before it was flattened to this extent owing to another cause. During the last (third) day, calm still continuing, it was crossed by a set of waves coming from the east. These were 3·28 feet (1 mètre) in height, and 174 feet (53 mètres) in wave length, about the same length as those met with afterwards when the ship entered the easterly trade winds. Here the south-westerly swell ceased to be visible, after having been traced for 150 leagues. The smaller swell from the trades was met with 50 leagues from the place where the easterly winds were blowing.

(*To be continued.*)

MONKEY HAND-PRINTS.

By R. Lydekker.

The arrangement of the fine ridges and grooves on the palmar aspect of the human hand has of late years been studied with great attention—first by Mr. Francis Galton, and subsequently by Mr. Henry, of the Bengal Police—in order to develop a satisfactory system of identification by means of "finger-prints." To that exceedingly important and interesting subject I shall devote a special article on a future occasion. In the present communication I desire, however, to draw attention to the arrangement of these lines on the hands of monkeys, and their function in both men and monkeys. This study seems to have been first seriously taken up by Dr. D. Hepburn, of Dublin, who communicated to the Dublin Society the results of his investigations, which were duly published in the *Transactions* of that Society. The method employed by Dr. Hepburn was to take impressions of the hands of living monkeys on plates of glass coated with printers' ink; but there are many difficulties connected with this operation, and in preparing a series of impressions for the Natural History Museum, it occurred to me that I might be able to take them on paper from the hands of monkeys recently deceased. I accordingly communicated with my friend, Mr. F. E. Beddard, the Prosector to the Zoological Society, asking him to be good enough to send me the right hands of some of the monkeys that died in the Society's menagerie. With this request he very kindly complied, and from the specimens which from time to time arrived at the Museum, I was enabled to take, among others, the impressions herewith reproduced. Although they are not quite so successful as might be desired, they are yet amply sufficient to show the general plan of arrangement of their lines, and the variation to which they are subject in different genera. Enlargements from these same impressions are now exhibited in the British (Natural History) Museum.

Before proceeding further I must disclaim any intention of poaching on the preserves of the so-called science of "palmistry." This, so far as I can understand its methods, deals exclusively with the folds or creases on the human palm (corresponding with the white lines in the annexed figures), while attention is here concentrated on the mode of arrangement of the raised ridges and their intervening grooves. It may, however, be mentioned that the creases in question have, both in man and monkeys, a definite mode of arrangement, which appears to be due to the position and action of the palmar muscles. What possible connection there can be between such muscular creases and the duration of human life or the vicissitudes of our mortal career may well be left for the professors of palmistry to explain as best they can!

As regards the structure of the palmar ridges, an examination of the reader's own hand with a lens will easily show that these consist of a series of very minute cone-like elevations, placed close together, and on the summits of which are situated the apertures of the sudoriferous or sweat glands. If a section of the skin

Fig. 1.—Right Palmar Imprint of a Macaque Monkey (*Macacus cynomolgus*); *a*, *b*, *c*, interdigital eminences; *d*, radial eminence; *e*, ulnar eminence.

be examined under a microscope, it will also be evident that within these papillæ are certain organs of touch known as the tactile bodies. Between the papillary ridges, as we may now term them, are situated the equally narrow grooves, which contain neither sweat-glands nor tactile bodies.

Looking carefully at Fig. 1, and, if necessary, employing the aid of a lens, it will be seen that the arrangement of the ridges and grooves, instead of being uniform over the entire palm, takes the shape of a series of definite patterns in certain areas, between which a more or less regular linear arrangement obtains. On the ball of each finger and the thumb, for example, it will be noticed that the ridges assume what may be termed a concentric pattern, in which the central ridges run longitudinally. Again, on the three eminences situated on the palm opposite the clefts between the four fingers, they take the form of concentric whorls (*a*, *b*, *c*). A similar radial eminence (*d*) with a whorl-like pattern is situated opposite the cleft between the thumb and the fore-finger; while yet another whorl-bearing elevation (*e*), which may be termed the ulnar eminence, has its position at the basal angle of the palm opposite the little finger. Minor eminences with much less distinct patterns, also occur on the palmar surfaces of the two basal joints of the fingers. Between these various pattern-bearing eminences, as is especially well shown on the fingers, the ridges and grooves tend to arrange themselves either in transverse lines, or (in the words of Dr. Hepburn) with such slight modification of this direction as would place them parallel to the long axis of any cylindrical object which might be grasped by the foot. It may be added that although in the human hand the patterns found on the balls of the fingers are frequently more complex than those in the monkey's hand, yet the converse of this is true with regard to the eminences on the palm itself, the ulnar whorl being generally quite obsolete in man.

In ordinary five-fingered monkeys, whether they hail from the Old World or from the New, the foregoing type of eminences is very constant. This is well exemplified by the impression of the hand of one of the South American Capuchin monkeys (Fig. 2). Here, however,

Fig. 2.—Right Palmar Impression of a Capuchin Monkey (*Cebus hypoleucus*).

Fig. 3.—Right Palmar Imprint of a Marmoset (*Hapale jacchus*).

the fingers are much longer and more slender than in the Old World macaque. In consequence of this the bulbs of the fingers are much less developed, so that it was found impossible to get a good impression of them. These features are even more developed in the hand of the tiny American marmosets (Fig. 3), in which the digits are more like claws than fingers, and consequently afford only a narrow and blurred impression. A peculiarity of the marmoset hand-print is to be found in the circumstance that the radial eminence has come up to form an arch with the three interdigital elevations, and that the ulnar elevation and pattern are obsolete. Seeing how comparatively wide apart from one another (both zoologically and geographically) are the ordinary monkeys of the Old and New Worlds, it is not a little remarkable that the palm-print of the macaque should be so strikingly like that of the capuchin.

This similarity (since everything in nature has a use) suggests that the patterns on the hands of these two monkeys are due to the same physiological cause; and we have now to enquire what that cause is. The best clue to the problem seems to be afforded, somewhat strangely, by the tails of such of the South American monkeys as are endowed with prehensile power in those appendages. Confirmatory evidence being likewise afforded by the prehensile tails of the American opossums and tree-porcupines, as well as by those of the Australian phalangers. In all these animals the naked, grasping portion of the tail, which is situated at the extremity, is covered with papillary ridges and grooves precisely similar to those on the hands and feet of monkeys, but invariably arranged in simple transverse lines across the tail, so that in the act of grasping they would be parallel to the long axis of the branch around which the tail was coiled. Clearly, then, papillary ridges are primarily connected with the grasping power, and when they are intended solely for that function they are so arranged as to be parallel to the axis of the object grasped. As regards this function of the papillary ridges, Dr. Hepburn observes that although they are comparatively low, "yet they must cause a certain amount of friction, and thereby prevent slipping, while the naturally moist and clammy condition of the palm and sole of monkeys must be of material assistance to the firmness of the grasp. A man instinctively moistens the palms of his hands when he wishes to make his grasp more secure; and the grasping power of monkeys must be considerably increased by the application of numerous papillary ridges which are capable of intimate adaptation to the surface of the object grasped."

In a later passage the same observer adds that, apart from the hook-like manner in which the orang-utan and the American spider-monkeys employ their hands in trapeze-like movements, there can be no doubt that the palms are capable of a considerable amount of lateral folding, as is proved by the creases to which allusion has been already made. And it appears probable that the papillary ridges are designed to afford increased firmness of grasp when the palms are thus folded. Consequently, simple transverse ridges on the palms, except in the second joints of the fingers, are conspicuous by their absence; and we find instead the complicated patterns on the eminences already described.

A somewhat different type of arrangement obtains in the hand of the South American spider-monkeys, in which the thumb is wanting. In this group it will be noticed (Fig. 4) that although whorl-like patterns

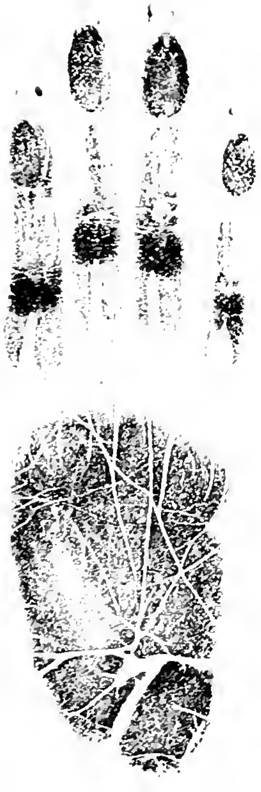


FIG. 4.—Right Palmar Impression of a Spider Monkey (*Ateles ater*).

are observable in the interdigital eminences, yet they are much smaller and less distinct than in ordinary monkeys; the same being the case with the ulnar eminence. The radial pattern, at the inner side of the thumb is, however, practically wanting, owing doubtless to the absence of that digit. It will further be noticed from an examination of the figure that elsewhere on the palm, not even excepting the [illegible], the general arrangement of the ridges is longitudinal. Since the hands of the spider-monkeys are, as already mentioned, largely used in a hook-like manner during the arboreal evolutions of these active creatures, it would seem at first sight that the arrangement of the ridges precisely controverts what has been said above as to their being parallel with the long axis of the object grasped. But the palms of even these monkeys, as is indicated by the numerous creases, are evidently much folded laterally; and it must also be borne in mind that an equally important function of the hand is the plucking and holding of spherical or sub-spherical fruits. And for such a combination of functions the mode of arrangement of the ridges is doubtless the one that is most suitable. If the ridges were transverse the fruit would very probably have a tendency to slip out of the hand on one side or the other; but this is clearly prevented by the longitudinal arrangement.

The above are the chief modifications displayed by the palm-prints of monkeys; and it may be added that a very similar general plan of arrangement of the papillary ridges and grooves obtains on the sole of the foot of these animals, subject, however, to such modification as is necessary for the different function of the foot as compared with the hand. But in some at least of their allies, the lemuroids, as represented by the true lemurs of Madagascar, the galagos and pottos of Africa, and the lorises and tarsier of Asia, a very curious departure from this arrangement obtains. In regard to the true lemurs it is generally stated that on the outside of the palm of the hand and under the base of the fingers are situated fleshy pads, giving them greater grasping power. This, however, is scarcely an adequate statement of the true state of the case. Fig. 5 shows

FIG. 5.—Right Palm-print of Red-fronted Lemur (*Lemur rufifrons*).

the palm-impression of the red-fronted lemur, a well known Malagasy species. In this it will be seen that the balls of the digits are expanded into large convex circular pads upon which are a number of papillary ridges; but instead of these ridges covering the whole surface of the pads, they are interrupted by an irregular net-work of relatively large canals, producing the white lines in the impression. On the palm of the animal are seen the three interdigital eminences of the monkey's hand, together with a large radial and a somewhat smaller ulnar eminence. The radial eminence is, however, divided into two portions by a deep groove, and on all five eminences are observable the usual papillary ridges and grooves traversed by the aforesaid irregular network of grooves. On the palmar aspect of the second joint of the fingers, and on such portion of the centre of the palm as exhibits an impression, the papillary ridges, instead of being uniformly distributed in regular lines, are restricted to certain small pustule-like eminences, on which, however, the linear arrangement is distinctly visible with the aid of a lens. And if it had been possible to obtain an impression of the basal joints of the fingers, a similar pattern would doubtless have been noticeable there also. Whether the curious arrangement of canals characteristic of the palm of the red-fronted lemur, or a modification thereof, obtains in all the true lemurs, must await the acquisition of additional fresh specimens of the hand; but in that species at all events it seems certain that these pads must have a kind of sucker-like action, which greatly increases the firmness of their owner's hold on the boughs it grasps.

Apparently this type of palm-structure culminates in the curious little tarsier of the Malay Islands, in which the long and slender toes terminate in round sucker-like disks; similar disks occurring on the toes of the hind-foot. Unfortunately I have had no opportunity of taking the palm-impression of a recently deceased tarsier, and it will probably be long before such a chance occurs, so that I can say nothing as to the mode of arrangement of the papillary ridges.

It may be added that the finger and toe-pads of those curious lizards commonly known as geckos are likewise modified into adhesive disks. But in this case the sucking action is caused by the skin being raised into a series of parallel plates, and as palmar eminences, as well as papillary ridges, are wanting, the structure is not apparently strictly comparable with what obtains in the tarsier and the lemurs.

But even the foregoing by no means exhausts the subject of palmar and plantar eminences. Anyone of my readers who takes the trouble to examine the feet of a cat, a dog, or a rabbit will find a number of bare elevated pads, covered with rough granular skin, interspersed among the generally hairy surface. In all cases, both in the fore and hind limb, one of these bare pads will be found occupying the lower surface of the terminal joint of each toe, lying immediately below the claw. And it will be quite obvious that these correspond to the pattern-bearing eminences occupying the balls of the thumb and fingers of the monkey. In regard to the pads on the palm and sole, these are subject to some degree of variation in the carnivora, and they may sometimes coalesce to such a degree that their original relations are more or less obscured. But in some of these animals* three distinct pads are observable in the fore-foot corresponding in position with the interdigital eminences of the monkey's palm. Continuing the semicircle formed by these three is a fourth pad, representing the radial eminence of the monkey, while further down on the palm is one corresponding to the ulnar eminence of the latter; a small additional pad being intercalated between the radial and ulnar.

It is thus fully demonstrated that the pads on the fore-foot of the dog and the cat correspond with the pattern-bearing eminences of the monkey's palm, and these again with the much less distinctly defined eminences on the human hand. In animals which use both feet exclusively for walking, it will, however, be obvious that delicate papillary ridges, designed partly for the purpose of obtaining a firm grip of any object seized, and partly to act as organs of touch, would be perfectly useless. And we accordingly find the papillary ridges of man and monkeys replaced in the cat, the dog, and the rabbit by granular conical elevations, which have, however, doubtless the same structure, and which are foreshadowed by the pustules on the finger and palm of the lemurs.

One other point remains to be mentioned. In all the lower monkeys that have been examined both by Dr. Hepburn and myself the pattern of the papillary ridges is of the concentric type (as shown in Fig. 1), in which the central ridges are longitudinal and the external ones form broad ellipses. In the chimpanzee, however, and probably also in some or all of the other man-like apes, the pattern on the balls of the fingers is of the form known as the looped type, which is of common occurrence in the fingers of the human hand. On the finger-tips of man alone occurs the still more complicated whorled type. The explanation of the characters of these two latter types may be reserved for an article devoted to human finger-prints; and it will accordingly suffice on this occasion to record the fact that even in such a minute detail as the arrangement of the lines on the fingers of the man-like apes and man stand apart from their kindred, and that in man alone is the most complicated type ever developed, although even in him it is comparatively rare.

* Those who are interested in the subject may turn to the figure of the foot pads of the linsang, given by the late Professor Mivart on page 158 of the *Proceedings* of the Zoological Society for the year 1882.

PHOTOGRAPHY "IN NATURAL COLOURS," BY THE McDONOUGH-JOLY PROCESS.

By H. Snowden Ward, F.R.P.S., Editor of *The Photogram*.

In the present state of scientific knowledge, and in writing for the readers of Knowledge itself, it is unnecessary to say anything about the general history of attempts to solve the problem of "photography in the colours of nature." It may be well, however, to briefly outline the history of the process now known as the McDonough-Joly, and perhaps, even before beginning the history, to explain why I write of an old process at this particular time. The reason is that this process has only just reached the point of thorough practicability, and that in a few months it ought to be possible for every photographer to obtain, at a very small cost, the necessary apparatus and materials.

I have no brief on behalf of this particular process, and I realise the great beauty and value—if you will, the *superior* beauty and value—of the results of the triple-film superposition process. The two methods supplement rather than antagonise each other, and each has its advantages. Those claimed for the McDonough-Joly process are that it requires the smallest possible alteration of existing apparatus, no change in existing methods, and necessitates only one exposure, with one lens, on one plate, to secure the triple colour-record. Further, from the negative so made, a single transparency can be prepared (in the same way as making an ordinary lantern-slide) for lantern projection, and a single printing by well-known processes will give a colour-print on paper. To project the transparency in colour, a colour-screen is necessary, and to make the print in colour it is necessary that the photographic sensitive surface shall have been laid by the manufacturer of the paper on a substratum ruled with alternate lines of red, green and blue, as will be explained later.

The history of the process is interesting and even romantic; for one of the early workers, a most fertile inventor, broke down entirely under the mental strain of his work, while another, James McDonough, wrecked his constitution by close and ceaseless application to research, and died within a day or two of the making of the first successful negatives by his process. The first published particulars of the process were given in a little book ("Les Couleurs en Photographie: Paris, Marion") issued in 1869, and written by Louis Ducos du Hauron, who had previously made communications on various modifications of a triple process of colour photography suggested by himself, on January 20th, 1859, before the Society of Arts and Sciences of Agen. This particular method was allowed to lie unused and undeveloped, and nothing more was heard of it until 1894, when it was patented, almost simultaneously, in Britain and America, by Dr. John Joly, of Dublin, and Mr. James McDonough, of Chicago. Both these workers seem to have devised the method independently, and without knowledge of the work of du Hauron.

The process is based upon the well-known triple negative process, in which, by means of plates sensitive to the various colours of light, and by the use of light-filters of coloured glass or coloured solutions, negatives are made separately of each of the primary colour-sensation effects. By the superposition of prints in corresponding coloured inks or pigments from each of these negatives, natural-colour prints may be made upon paper, as in the well-known process of trichromatic letterpress printing. Similarly, the superposition of three transparencies or positives in stained gelatine, gives us a natural colour transparency or lantern-slide.

In the McDonough-Joly process, the three negatives are made upon one plate by the simple expedient of replacing the three successive light-filters by a "screen" ruled with fine lines of transparent stained gelatine in successive rulings of red, green, blue, red, green, blue. Each of these lines is $\frac{1}{300}$ of an inch in width, and they are ruled so as to touch, edge to edge, thus entirely covering the glass of the screen. These ruled lines are pressed into contact with the sensitive dry-plate during the exposure in the camera, with the result that the negative so made consists of lines of silver deposited under the lines of the screen. Thus, supposing a blue object, reflecting light of exactly the colour of the blue line of the screen, was photographed, the negative would show two lines of clear glass (under the red and green) while under every blue line the silver would be strongly deposited. Thus, every third line may be considered as part of a distinct negative, recording one of the three primary colour sensations. Where an object reflects light of a composite colour, both the colours that go to make up the composite will be affected. Thus, if the object is yellow, it will be represented under both the red and the green lines.

From the colour-effect negative, which looks just like any ordinary negative except for the fine lines, a transparency may be made by exposing a sensitive plate in contact, and developing in the same way as in making an ordinary lantern-slide. This is, of course, a reverse of the negative, so that in the suppositious case of the blue object the transparency would show silver deposit in parts corresponding to the red and green lines, with clear spaces corresponding to the blue. To view the picture this positive transparency is placed in contact with a lined colour-screen somewhat similar to the one used in making the original exposure. Looking through the combined transparency and screen, one sees that the silver deposit in the transparency obscures the red and green, allowing the blue to be plainly seen.

The same sort of thing happens with photographic prints on paper. The raw paper is first ruled with the fine red, green, and blue lines, after which it is coated (say) with a sensitive gelatino-chloride emulsion, thus converting it into P.O.P. or print-out paper. The negative is placed upon a sheet of this, taking care to register the lines of the negative exactly over their proper colour-lines on the paper. The printing causes the parts of the paper to which the light has access to become dark-brown with the opaque reduced silver as under those lines of the negative which are transparent, because the light from the original object has not acted upon them. The photographic image forms a stencil or mask to the coloured lines, just as it did with the positive transparency.

In photo-mechanical printing, a metal printing-block takes the place of the negative, and a dense printing-ink (black or a neutral grey) replaces the silver deposit.

The lines, when ruled three hundred to the inch, are so fine that, viewing a picture as a whole, from any reasonable distance, they are quite inoffensive.

Intermediate colours, made by the reflection of varying proportions of the primaries from lines so fine that the eye does not separate them, are purer and better than those made by transmission of the light through three superposed films—always supposing, which is not at present the case, that the original colours are equally good and pure in each instance. On the other hand, the dark "stencil" image, occupying a large proportion of the space, tends to lower the tones throughout the picture; except in the case of a transparency with ample illumination.

Many difficulties which beset the process, and which rendered it practically impossible when first suggested, have been removed in the general progress of photography, without any effort on the part of those interested in the process itself. These difficulties chiefly related to the obtaining of plates sensitive enough to the red rays of light to render short exposures possible; and plates which should be fairly sensitive to the whole range of the spectrum. The great attention given to orthochromatic photography has led to the production of such plates, and immensely helped all natural colour investigators.

The difficulties peculiar to the McDonough-Joly process are chiefly connected with the manufacture of the colour-screen. The problem was to rule screens that should be cheap, transparent, permanent in colour, fine enough to prevent the lines being offensive, yet coarse enough to make registration on viewing screens or on ruled paper, sufficiently easy. The people interested in developing the process, headed by Mr. D. K. Tripp, of Chicago, have decided upon the standard gauge of three hundred lines to the inch, and as the result of a few weeks' working with negatives and transparencies on that scale I conclude that it is a very practical arrangement. As to the permanency of the screens, I have some of Dr. Joly's make, which seem to show no deterioration in a couple of years or so; and I am informed that some of Mr. McDonough's have been exposed for about five years without apparent change.

The question of price is, of course, most important, for if every transparency is to have its separate viewing screen the screens need to be cheap. At present the demand for screens can not be supplied at any price, because only the experimental ruling machinery is available, and its capacity is very small, but Mr. Tripp informs me that as soon as machinery now building is completed it will be possible to supply viewing screens of the American standard lantern-slide size (4 in. × $3\frac{1}{4}$ in.) at $2 a dozen, or say, eightpence each; and that in the course of a couple of years it should be possible to make them for one or two shillings a dozen. As for the ruled paper, since prints made upon it, photo-mechanically, can compete in price with prints by the trichromatic process, the ruling itself must be done very cheaply, and there is no apparent reason why paper ruled from the reel, and printed with registering marks to correspond with similar marks on the camera screen, should not be supplied to the photographic paper-makers at a price that will add but little to the price of their product.

As regards the transparencies and prints made by this process, one must admit that their "truth to nature" is dependent upon care in the photographing. Exposure, development, and printing offer as great a field for the personal influence in this, as in the ordinary monochrome methods of photography. While one man will represent nature in the brilliant hues of a modern French water-colour or chromo, another will give us the same scene lost in the brown-varnish gloom of an oil-painting by an old master. The scientific man who wants bold accuracy can secure it; while he who has the artist's fancy and imagination can let them wander at will in fields of colour, just as he now attempts to satisfy them with variations of tone and texture.

BIRD-LOVE IN WINTER.

By Charles A. Witchell.

Although the season of nidification is the time when birds seem the most erotic, there is no little evidence that a degree of mutual affection between birds of opposite sex often exists at other periods of the year. Much of this evidence is perhaps hardly within the scope of scientific proof; but some of it, on the other hand, is strongly suggestive of at least a kindly interest, though this be indicated only by couples of birds separating themselves from others in the same assemblage or company. Among the more solitary common species the same nest-places, dormitories, and general habitats are usually tenanted by what seem to be the same respective pairs of birds. The crow, magpie, and kestrel are familiar instances. It is clear that in these cases there is at least no ill-will existent between the birds of a pair; they seem not to bicker and snap at each other; nor to derive satisfaction from each other's misfortunes; but to desire each the presence of the other, and to be content in it. Selective companionship, therefore, is our first piece of evidence; and it is given, not only by the solitary birds, but also by some of the gregarious kinds. Why do the jackdaws and rooks in evening flight to the great roost-place so often fly in couples, even as early as September, unless it be that they have begun to select their mates for the next year? They do not behave thus on every evening, for when the wind is high, or they are flying down-wind, the couples are broken, if, indeed, ever formed. But on a still autumnal evening, when the birds are not seeking food nor avoiding enemies, but merely passing onward to the accustomed resort, four-fifths of them, at least, fly in couples. The jackdaws are the more restless, some of the couples being disturbed by one or more erratic and noisy members of the troop; but most of them, like the more staid rooks, seem to prefer to have one only near them. Although at first sight the statement may seem hardly credible, I have noticed similar behaviour in small groups of starlings flying to roost. When living at Eltham I had constant opportunities of observing this, for at evening immense numbers of starlings assembled in the near thickets, and I was often surprised to notice, even in autumn, how many birds in the small clusters had distinctly tended to arrange themselves in couples, though the preference only attained to the lessening of the average distance in the flock, to the extent of a few feet, between the particular birds. In the case of the rook and jackdaw the young birds of the year seem to demonstrate this selective association as freely as the old birds, but the natural tendencies of starlings in this respect are less discernible, for the latter birds are much the more timid of aerial enemies—and justly so. The sight of a sparrow-hawk will break up their formation in a moment, and send the scattered detachments streaming wildly about the sky, or scurrying low among the tree-tops.

Friendly hawks not only tolerate each other's presence in autumn and winter, but sometimes indulge in bye-play suggestive of at least a kindly interest in each other. In October last, one breezy day on the Cotteswolds, a male and female kestrel came into view flying lazily. They soared and drifted somewhat, and then swooped at each other more than once, obviously in play; and then drifted on as before. At the end of November I was watching a pretty male kestrel searching a hillside. Presently across the valley came another kestrel, a female bird, going directly towards him. She passed in full view, and it was noticeable that she was not flying quite in the usual way, but with very rapid and ceaseless beat of wing, and yet not travelling at a great pace. She did not alter or stay her course; but the other did not seem to fear her at all, and let her stoop full at him, as though he knew she would not hurt him. As a fact, she seemed to lessen her speed when approaching him; for she spread her wings, and swung at him like that; and both birds soon afterwards settled in a tree. It seemed that by this mode of approach she was showing a kindly interest in her mate—six months before nesting-time. Her flight reminded me of that of an amorous lark or chaffinch.

The call-notes and songs naturally afford much stronger evidence than what is above written, of the existence of winter-love in birds. So far back as September, the robin was in full song; and, although he always sang before fighting another singer, still there was often near him a robin which did not sing, and which he did not attack, but to which, very possibly, some of the songs may have been addressed, for, at that season, the call-note of the singer was heard almost as often as it is in early spring. Throughout the cold season the presence of that silent robin is tolerated by the singer, though the vocal rival is persistently attacked. The starling has love-notes in his song all the winter.

The wren, another autumn singer, makes great use of its call-note at the time of the falling leaf. In a garden is a wren's nest, I know, which has been in existence for two years. Eggs have never been laid in it, and in summer the presence of spiders' webs across the opening indicates that the tenement is then unoccupied; but in winter the webs are not there, and a wren may be seen going in and out. In November, in a tree close to the nest, were two wrens, about a foot apart: the one, with head raised, was obviously addressing the other with continuous call-notes. One would have required to shoot the birds to establish their sexual identification, but without that one might fairly assume that here was an instance of winter-love. A few days later, in another district, I saw two wrens behaving in a precisely similar manner. The incident is, indeed, a common one.

In autumn the hedge-sparrows seem to be choosing mates for the winter and next year, for we see a silent and timid one pursued by one or more twittering and fluttering others, and are able easily to recognise a study in the art of love, as the gentler birds understand it. At that time the male house sparrows have recommenced their mobbing of their much-worried female relations, and throughout the winter pairs of this species sleep in accustomed shelters. The great titmouse seems to have selected his mate before Christmas, at which time the birds are generally travelling in couples, though often two couples are in the same resort. This is in keeping with the resumption of the bird's clinking song-note in autumn. Nuthatches likewise are generally found in couples, before the cold weather has commenced, and, throughout it, owls may be heard hooting and calling.

Although the finches and allied birds do not generally sing in the cold, one cannot say that attachments between the sexes do not then exist, except, perhaps, in the case of the bachelor chaffinch. The male bullfinch is generally accompanied by his mate, and if either is disturbed it does not retreat without calling the other. Even the greenfinch, gregarious as he is in winter, seems sometimes then to travel in couples. In the severe winter of 1894-5 I killed some fifty greenfinches in a garden, to supply the larder of a kestrel which seemed to be worth the sacrifice, and I soon noticed that the successive finches appeared in pairs, or in small groups of even number. Only once or twice was an odd number of them taken. The attraction was some loose straw, and the trap a spring-net, which could be released as desired. Directly after a pair of the birds had met their fate another pair appeared, and finally a couple nested in the garden, as usual.

At the moment of writing (early in December) I have been watching the amorous antics of four couples of jackdaws, each couple keeping aloof from the others, though all were in the same spot. Most of them were garrulous as usual; and, in flight, a leading bird would sometimes descend on drooped wings, uttering meanwhile the long rough "carr," which seems to be the love-note of the species. But two of them, perched high in an elm, were actually preening or pecking each other's feathers in a gentle manner. I have never before seen other birds than pigeons do this, and then only at nesting-time, but through a telescope (× 11 dia.) the movements of the birds were clearly visible.

The rook, however, seems to furnish the strongest instance of affection in the dead season. My brother, Mr. E. N. Witchell, who sometimes resides near Minchinhampton Down, has often in winter seen one of the rooks which abound there take to another some morsel of food. Quite recently he saw a rook take up something, hop away to another rook, and give up the prize, which the receiver ate. The rook has as good an appetite as any other bird, and such an instance as this is proof of a bond between the birds higher than mere mutual association for detecting danger, or preferential companionship. Many of us are seemingly too ready to estimate bird-love at the level of the poultry-yard, or at any rate to consider it as incidental to springtime only. In several species this estimate seems to be supported by fact; but in others "love" seems to be of a more enduring and a nobler kind.

NOTES.

ASTRONOMICAL.—From spectroscopic observations, Mr. Newall has found that the velocity of α Persei is variable, with a period of possibly four or sixteen days. Presumably, therefore, this is another star which has a relatively dark companion. Such systems, as pointed out by Prof. Campbell some time ago, are probably at least as plentiful as visual binaries.

A special interest attaches to the spectroscopic binary Capella, independently discovered by Mr Newall and Prof. Campbell, for the reason that the companion is sufficiently luminous to show a spectrum, and the computations suggested that the components might be separated visually in a powerful telescope. With the 28-inch refractor at Greenwich, an "elongation" of the star, amounting to at least a tenth of a second, has been observed, in accordance with the spectroscopic observations, but Prof. Hussey, observing with powers up to 2600 on the Lick refractor, has failed to find either elongation or separation.

As a result of measurements of one of the charts already published in heliogravure by the French observatories taking part in the International Astrographic Chart of the Heavens, Prof. Turner considers it probable that they yield star places at least as good as those obtained with meridian instruments. It appears, however, that the complete results, if produced in the same careful manner, would cost each of the eighteen participating observatories no less than £10,000.

M. Deslandres, of Meudon, believes that he has succeeded in registering, by means of the infra-red rays, the general form of the solar corona without an eclipse. The eclipse results on which his method is based, however, appear to be at variance with those obtained by Prof. Langley.—A. F.

BOTANICAL.—A caoutchouc-producing plant, which gives promise of thriving under cultivation, unprotected, in a temperate climate, is now, according to the *Revue des Cultures Coloniales*, engaging the attention of the officers of the Jardin Colonial at Vincennes, near Paris. This plant, *Eucommia ulmoides*, has been for some time an object of considerable interest to botanists, an interest increased in consequence of its bark being highly esteemed by the Chinese as a tonic medicine. Its first appearance in this country, about ten years ago, was due to Dr A. Henry, who sent specimens from Hupeh, China. Shortly after it was described and figured in *Hooker's Icones Plantarum*. An elastic gum-like substance, abundantly present in almost every part of the plant, formed the subject of an important paper by Professor Weiss in the *Transactions of the Linnean Society*. The French propose to introduce the *Eucommia* into Anam, Tonquin, and their colonies in North Africa.

Instances of variation from the normal opposite or whorled arrangement of the leaves in Labiatae, excluding such as would be considered in a work on plant teratology, are exceedingly few. Their existence, however, has formed the subject of a paper, which Messrs. Burkill and Wright have contributed to the last volume of the *Journal of the Linnean Society*. About four years ago, a French botanist, M. Hua, established the genus *Icomum* on a tropical

African plant with distinctly alternate leaves. To this genus Messrs. Burkill and Wright have now added three more species, each possessing the same peculiarity of leaf arrangement. Further, they include in their paper a description of a new alternate-leaved *Plectranthus*, thus making a total of five species of African Labiatae characterised by alternation of leaves.

The recent enumeration of Chinese oaks, published in the *Journal of the Linnean Society*, includes nearly sixty species, many of which exhibit some remarkable deviations in habit, leaves, and particularly in fruits, from the British representative of the genus. *Quercus cornea*, one of the most interesting in the structure of the acorn, is the subject of a plate in the last part of *Hooker's Icones Plantarum*. The woody involucre envelops all but the broad top of the curiously shaped acorn, to which it remains firmly attached even when the fruit is quite mature. In common with a few other East Asiatic species, the extremely hard pericarp forms ingrowths into the cell-cavity, incompletely dividing it into four or five cells, and causing the cotyledons to become lobed, as in the walnut. Its acorn, known to the Chinese as "Shi-li" (Stony Chestnut) or "King-li" (Peking Chestnut), is sold in the markets of South China as an article of food.—S. A. S.

ENTOMOLOGICAL. — Everyone knows the care for their young displayed by ants, wasps, and bees, but parental affection in beetles is not so familiar, though several instances are known to naturalists. A recent observation on this subject is due to Dr. J. E. V. Boas, who, in a paper "Ueber einen Fall von Brutpflege bei einem Bockkäfer" (*Zoolog. Jahrb.* (*Abth. f. Syst. u.s.w.*), xiii., 1900, pp. 247-257, taf. xxii.), has given an account of the operations of the willow longhorn beetle (*Saperda populnea*) when egg-laying. The female makes a horse-shoe-shaped cut in the bark of a twig, afterwards forming transverse furrows across the enclosed area. The egg is laid at the central point of the arch of the horseshoe marking. This work of the mother beetle induces a pathological condition in the wood, which leads to the formation of a gall-like growth, affording a suitable food supply for the growing grub.

Musical Beetles.—The last issued part of the *Transactions of the Entomological Society* (1900, pp. 433-452, pl. vii.) contains an interesting paper on "Stridulating Organs in Coleoptera," by Mr. C. J. Gahan. His researches confirm Darwin's observations in the "Descent of Man," that these organs are "wonderfully diversified in position," though their structure is usually simple, consisting of a series of fine striations over which a tile-like area or a rasping edge, formed by some neighbouring part of the exoskeleton, plays. In many cases the striated area is divided into a coarser or finer portion, whence it appears that notes of varying pitch can be produced. The best known of "musical beetles" are probably the long-horns, which rub the movable prothorax over a striated area on the mesonotum; but stridulating organs may occur on the head, legs, wing-cases, and hind-body. It is remarkable that a similar organ may be developed in widely different families in exactly the same position on the beetle's body. Although these organs are often equally developed in both sexes, Mr. Gahan inclines to the theory of sexual selection as their probable explanation. But the presence of "musical boxes" on the grubs of beetles is much more puzzling, especially as they occur in groups that live underground (as the chafers and dor-beetles), or burrowing in wood (like the stag-beetles and passalids). In these grubs the roughened areas are on the haunches of the middle legs, and the scrapers on the hind-legs; in the passalid grubs the hind-legs are so reduced that they are useless for anything else than sound-producing. It has been suggested that "with a number of larvæ living close together in the way described, it would be an advantage to each to be left in undisturbed possession of its burrow. . . . Stridulation acting as a sort of declaration of each individual's rights would tend to promote general harmony."—G. H. C.

ZOOLOGICAL. The discovery by Major A. Gibbons of the white, or Burchell's, rhinoceros (*R. simus*) to the north of the equator, near Lado, removes one species from the list of animals threatened with impending extermination. Previously, this animal was considered to be practically confined to the region bounded by the Zambesi and Orange Rivers. Among other African animals bordering on extinction is the mountain zebra (*Equus zebra*) of Cape Colony; it is therefore fortunate that a nearly allied form has been discovered in Angola and the adjacent districts, of which specimens have recently been sent to this country by Mr. W. Penrice.

Several of the West African mammals are of archaic types, and it is now urged by Miss A. Carlsson that the two-spotted paradoxure (*Nandinia binotata*) is nearly related to *Amphictis*, of the Oligocene of France. *Nandinia* is also peculiar in possessing a kind of rudimentary abdominal pouch, the presence of which has led one writer to suggest that the creature is a marsupial instead of a civet.

A palæontological contribution of much interest is one by Prof. H. F. Osborn in the October number of the *American Naturalist*, dealing with the question of the relationship of birds to the extinct dinosaurian reptiles. Although it is considered that many of the resemblances between these groups are due to adaptation for the upright posture, the author comes to the conclusion that birds are probably an early offshoot from the dinosaurian stock before that posture had been attained by any of its members.

It is interesting to find that, according to a paper contributed by Prof. E. Fraas to the *Fundberichte aus Schwaben*, the ancient Romans were well acquainted with the difference between the bison and the wild ox, or aurochs; characteristic statuettes of both species having been discovered. Dr. Fraas refers the bison thus represented to the extinct *Bos priscus*, although we should have thought it more likely to be identical with the living *B. bonassus*.

The worm-like *Balanoglossus* and its kindred form are one of the most interesting groups of invertebrates on account of their relationship to the vertebrates; therefore every new fact connected with them is of importance. In the *Transactions* of the New Zealand Institute for 1899, Prof. Benham records the presence of the above-named genus in New Zealand waters; while in the *Proceedings* of the Washington Academy for August Mr. W. E. Ritter describes the new genus *Harrimania* from the Alaskan coast.

For the first time in its long career the Zoological Society's menagerie in the Regent's Park has received living examples of the tenrecs (*Centetidæ*) of Madagascar, most or all of which have been received on deposit from the Hon. Walter Rothschild. The tenrecs are some of the most curious and primitive of the insectivorous mammals, and are entirely restricted to Madagascar. Their spiny covering gives them a superficial resemblance to hedgehogs, from which, however, they differ markedly in the form of their teeth, as well as in many other characters. Several specimens belong to the common tenrec (*Centetes ecaudatus*), but one indicates a different type. The former show that the stuffed specimens in museums give no adequate idea of the form of these strange animals, whose

CLUSTERS M. 35 AND H VI. 17 GEMINORUM.

NEBULÆ IN MONOCEROS

By ISAAC ROBERTS, D Sc., F R S

bodies may be compared to those of inflated globe fish. Perhaps the most peculiar feature about them is the swollen condition of the hinder part of the palate, which is, of course, only seen when they yawn—a habit in which they seem fond of indulging.

Another animal at the "Zoo" never before exhibited alive in this country is the white goat of the Rocky Mountains, one of the few species of mammals that are white at all seasons. We purposely allude to this animal by its popular name, since naturalists are not in accord as to its proper scientific title: English writers generally calling it *Haploceros* (or *Aploceros*), while Americans prefer *Oreamnus*. We think the latter are in the right.

The German naturalist Hermann Klaatsch has made the interesting discovery that, with the exception of the man-like apes, none of the Old World monkeys possess a muscle corresponding with the one known in human anatomy as the short head of the *biceps flexor cruris*. And since the representative of the same muscle, under two different modifications, occurs in the American monkeys, the question whether these are more nearly related to man and the man-like apes than are the ordinary monkeys of the Old World is opened up.

International Catalogue of Scientific Literature.—At meetings of the council of this important undertaking held on December 12th and 13th, the object, scope, and organisation as defined by successive conferences held during the last four years were brought into their final form, and all arrangements were completed for the definitive commencement of the work on January 1. The catalogue will at first be issued in annual volumes, but its form and rate of production will necessarily be governed to a great extent by financial considerations. The responsibility for publication and for the initial expenditure is undertaken by the Royal Society, and the central bureau will be in London, while regional bureaux in correspondence therewith will of course be established in all the countries taking part in the undertaking. A comprehensive and elaborate system of classification has been devised with the assent of all the countries interested.

PHOTOGRAPHS OF THE CLUSTERS M. 35 AND H VI. 17 GEMINORUM, AND OF NEBULÆ IN MONOCEROS.

By Isaac Roberts, d.sc., f.r.s.

CLUSTERS M. 35 AND H VI. 17 GEMINORUM, AND OF THE STARS AROUND THEM.

The photograph exhibits the region in the sky between R.A. 6h. 0m. 24s. and R.A. 6h. 1m. 39s., and in declination between 23° 34′·0 and 21° 58′·3 north. The area is, therefore, 1m. 15s. in extent from *preceding* to *following*, and 1° 21′·3 from north to south.

Scale, one millimetre to thirty seconds of arc.

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

Star (a) D.M. N. 1195 Zone + 2[illegible] R.A. 6h. 0m. 17·1s. Dec. N. 24° [illegible] Mag. 8·7.
Star (b) D.M. N. 12[illegible] Zone + 2[illegible] R.A. 6h. 2m. 4·2s. Dec. N. 2[illegible] Mag. 8·5.
Star (c) D.M. N. 1[illegible] Zone + 23 R.A. 6h. [illegible] 31·2s. Dec. N. 2[illegible] Mag. 8·4.

References.

N.G.C. 2168. G.C. 1360. *h.* 377. Rosse, *Obs. of Neb. and Cl.*, p. 52. Lassell, *Mem. R.A.S.*, Vol. XXIII., p. 59. *I.R. Photos.*, pl. 19, p. 63. H VI. 17, G.C. No. 1351.

The photograph was taken with the 20-inch reflector on January 20th, 1900, between sidereal time 4h. 12m. and 5h. 42m., with an exposure of the plate during ninety minutes; and the stars are depicted to about 17th magnitude. The cluster M. 35 occupies the [illegible] part of scattered bright and faint stars on the north following side of the centre, and H VI. 17 is the small cluster on the south preceding side. Both clusters and the stars surrounding them present in a striking manner numerous curves and lines of stars with vacant spaces between them which enable us to see the dark areas of space beyond the Galactic universe, of which the solar system forms a relatively insignificant point.

Many astronomers have tacitly adopted the assumption that the stars extend indefinitely into the expanse of space, but that the reason they cannot be seen is the absence of sufficient telescopic power to reveal the very feeble light of stars that are beyond the range limit of all existing telescopes. But the evidence obtained by the aid of photography during the past twelve years strongly indicates, if it does not demonstrate, that those vacant spaces which are visible on photographs that have been exposed to the sky during intervals of seven to twelve hours are really void of stars. This inference is based upon the fact that photographs have been taken of identically the same areas in the sky but with exposures of only ninety minutes show the same stars, including those of the faintest magnitude, that were shown on the plates exposed up to twelve hours. Therefore we are justified (by our present knowledge) in adopting the inference that no fainter stars exist, and that the universe which includes all the stars and the nebulosity of the *Milky Way* is limited in extent, and that it may be considered as a separate and distinct aggregation of stars and of material of which stars are made independently of other similar stellar aggregations which may exist in the inconceivable expanse of space beyond the *Milky Way*. This view, based as it is on credible evidence, would reduce the whole of the solar system, including the planets and satellites, to a mere speck relatively with the Galactic universe alone, and relatively with the others that may be beyond, inconceivably small—a microscopic speck. What then about the earth, which we naturally look upon as a world of great importance? Important of course it is to the million forms of life that exist upon it, ranging between the monad and the elephant, or the whale, or man, but very small relatively with the solar system and insignificant relatively with the Galactic universe.

Some minds are slowly developing and forming conceptions which in time will enable them to appreciate the grandeur of the views of nature as they are revealed to us by recent researches in astronomical and in other branches of science; but general enlightenment must necessarily be slow, for the propagation of ancient obscurantist ideas oppose and greatly retard progress in the development of reason founded upon a basis more substantial than the waking dreams of obscurantists.

NEBULÆ IN MONOCEROS.

The photograph exhibits the nebulæ and the region surrounding them between R.A. 6h. 21m. 7s. and R.A. 6h. 28m. 0s., and in declination between 9° 12′·4 and 10° 36′·1 north. The sky area represented is, therefore, 3m. 53s. in extent from *preceding* to *following*, and 1° 23′·7 from north to south.

Scale, one millimetre to thirty seconds of arc.

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

Star (a) D.M. [illegible] Zone + 1[illegible] R.A. 6h. [illegible] Dec. N. 10° [illegible] Mag. [illegible]
Star (b) D.M. N. 11[illegible] Zone + 1[illegible] R.A. 6h. 27m. 1[illegible] Dec. N. [illegible] Mag. [illegible]
Star (c) D.M. N. 11[illegible] Zone [illegible] R.A. 6h. 2[illegible]m. [illegible] Dec. N. [illegible] Mag. 8·7.

REFERENCES.

N G C 2245-47. Index Catalogue No. 446-7.

The photograph was taken with the 20-inch reflector on March 1st, 1900, between sidereal time 6h. 28m., and 9h. 15m., with an exposure of the plate during two hours and forty-seven minutes. The star marked with two dots (..) is H IV. 3, N.G.C. No. 2245, and it is surrounded by faint nebulosity. The star marked with three dots is described as a nebulous star; and so also is the bright star, at a distance from it on the *north preceding* side, described as a nebulous star of 10th magnitude (Index Catalogue No. 446), but it is shown on the negative to be surrounded by extensive nebulosity with an area void of stars extending towards the south and *south following* directions. The star marked with one dot is apparently involved in the large nebula near the centre of the photograph, and on the *preceding* side of the star is a dark tortuous rift similar in character to that shown on the photograph of H IV. 41 Sagittarii and on others. The rifts prove that the nebulæ are not globular masses, but are like clouds with relatively small depths, and that we can see through them into the darkness of space beyond. There are also very noticeable areas void of stars in the region surrounding the nebulæ here described; and the lines and curves of stars are numerous in this region.

CONSTELLATION STUDIES.

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

I.—THE NORTH CIRCUMPOLAR STARS.

THE workman is nothing without his tools. For the astronomer in general these are his telescopes; his transit circle; his equatorials. But the fathers of the science had none of these, and they supplied the want by making themselves thoroughly acquainted with the groupings of the stars. The naked-eye astronomer of to-day is compelled to follow their example. The stars are his reference points and he must know them thoroughly; he cannot know them too well, and the more complete and exact his acquaintance with them, the better he is equipped for his work. It is by the stars that he marks the beginning and ending of a meteor's flight; by the stars he lays down the windings and channels of the Milky Way, or the soft contours of the Zodiacal Light. I have felt it, therefore, necessary to follow my little notes on the various departments of "Astronomy Without a Telescope" by a series of "Constellation Studies"; an introduction of the student, I would hope, to that fuller, more intimate acquaintance with the stellar groupings which continued and careful star-study will soon give to him.

When, where, or why, the constellations were designed and their names given them, are questions which have received much attention but which remain without a complete solution. The sources from which light can come on these questions may be divided under four chief heads. First. Folk-lore, or oral tradition. This is a rapidly-vanishing factor, and, on that account, it is the more to be desired that those who are brought in contact with the isolated peoples in the corners of the earth should lose no opportunity of trying to find out what these have noticed about the stars, what special groups they recognise, what names they have given them, and what traditions they have preserved about them. Next, what may be called documentary evidence; allusions in classical writers, and the astronomical records of India and China. Thirdly, what we may term—to use a popular and convenient, though somewhat inappropriate expression—the "Assyriological" source; the evidence of monuments and tablets recently discovered in the valley of the Euphrates. This source promises to be the most fruitful and significant, reaching back into a great antiquity, though it has come into our hands but lately. Lastly, there is the evidence of the constellation groups themselves. This internal evidence is necessarily very limited in its character, yet so far as it goes, it is the most important and unmistakable of all; and is especially valuable when it can be applied as a check to assertions or theories based upon external records of either of the three foregoing categories. To follow up any of these researches is also astronomy—"astronomy without a telescope"—although it is not the astronomy of observation. But the material already gathered under these various heads is far too wide to be at all adequately dealt with in the present series of papers. All that can be done will be to give occasional brief notes as to the names of star groups and of individual stars with their most probable meanings.

The most important stars for the student to begin with are those within the circle of "perpetual apparition," the circumpolar stars—those, that is to say, that are within 50° of the north pole of the heavens. A description of these was given in the number of KNOWLEDGE for April, 1900, to which I would make the following additions.

The constellations that immediately surround the North Pole are six in number, five of them ancient; the sixth, Camelopardus, or the Giraffe, was added by Hevelius about 1690.

There is no place for hesitation as to which of these constellations we should begin with.

> "He would scan the figured skies,
> Its brightest gems to tell,
> Must first direct his mind's eye north,
> And learn the Bear's stars well";

the seven stars so well known to our own peasantry as the "Plough" or "Charles' Wain." Wherever men have taken any notice of the stars at all, these seven have been recognised as a natural group, and in earlier ages, being then much nearer to the Pole than now, they were amongst the stars always visible, not only to dwellers in such northern latitudes as our own, but as far south as the tropic of Cancer. It is easy to see how the names of "Plough" or "Wagon" for these seven stars have arisen; their natural configuration has suggested them. The three stars below, as we look at the constellation at midnight at this season of the year, suggest just the kind of curve of a plough handle; and the four above in a rough rectangle, present the ploughshare. Or the four stars above may be considered the four wheels of the rude wagon of which the three below represent the heads of the three horses. "Chariot" or "Wagon" the seven stars have been not only in Northern Europe in our own time but in ancient Greece, and still more ancient Babylonia. Aratus writes of the Pole:—

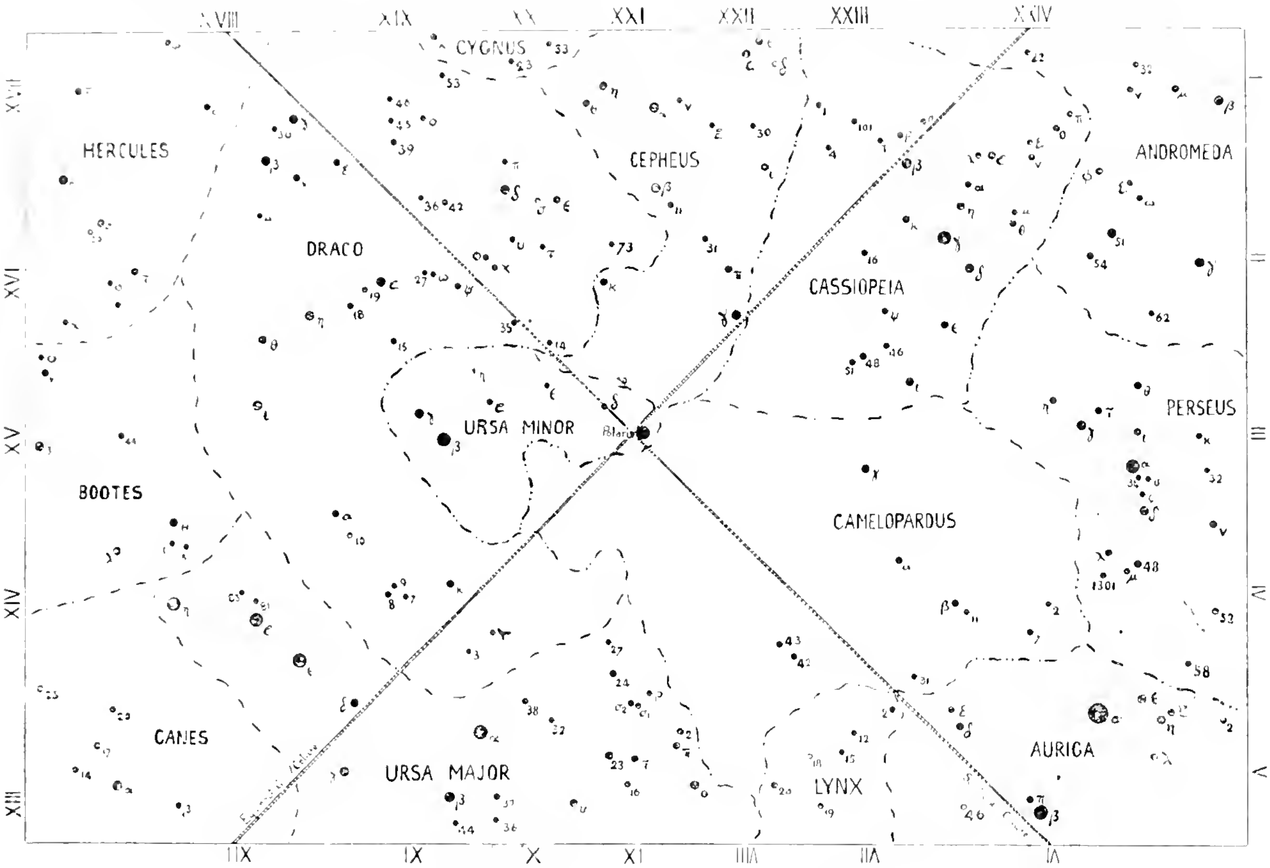
> "Two Bears
> Called Wains moved round it either in her place."

And Homer says that on the shield of Achilles were

> "All those stars with which the brows of ample heaven are crowned,
> Orion, all the Pleiades, and those seven Atlas got —
> The close-beamed Hyades, the Bear surnamed the Chariot."

But how the constellation got the name of the Bear is far harder to explain. The Sanskrit name "Riksha" signifies both "Bear" and "Star," that is, "bright" or "shining" one, and the latter word, very justly applicable to the seven stars as being pre-eminently the stars, the shining ones of the northern sky, may perhaps have been punningly represented by the figure of a bear. But this assumes that the title is Aryan in its origin, which is indeed far from certain. In default of a better theory I am myself inclined to think that the three striking pairs of stars below the Plough suggested the feet of a great plantigrade animal. The Lesser Bear no doubt obtained its name from the greater, since its principal stars are a distorted and fainter copy of the seven brilliants of its near neighbour. Classical tradition, according to Aratus, held that they were transferred to heaven as a reward for hiding Zeus in Crete, from his cannibal father Kronos, or else the Great Bear is Callisto, one of Zeus's many loves, and Arcas the Lesser Bear her son. The seven great stars in Job, Chap. xxxviii., the patriarch is asked, "Canst thou guide Arcturus with his sons?" "Arcturus" being the erroneous rendering adopted in the A.V. for "Ash," the "Bear," or the "Assembly." The star preserves to us, therefore, almost unchanged the name which the constellation bore at the time when the sacred drama of Job was written.

By far the most interesting object in the whole constellation to the "astronomer without a telescope" is Mizar with its near companion Alcor, 80 in Flamsteed's enumeration. Mizar is in every way the first of the double stars. Alcor forms with it a double to the eye; it has a much closer bright companion which rendered it the first double star to be detected in the telescope, it was the first double star to be photographed, and it was the first case in which the spectroscope showed that the principal star which appears to us even with the most powerful telescope as single is really in



Star Map No. 1: North Circumpolar Region.

of the Plough are now known by the seven first letters of the Greek alphabet, proceeding in order from the front of the ploughshare back to the handle. The names which they popularly bear at the present day are as follows:—Alpha is Dubhe, that is, the "bear"; Beta, Merak the "loin"; Gamma is Phecda the "thigh"; Delta, the faintest of the seven, is Megrez, "the root of the tail"; Epsilon is usually called Alioth; but whether this name has much authority is not clear; Zeta is Mizar, a "girdle" or "waistcloth" but this is a comparatively modern appellation; Eta, the star at the tip of the tail, has the most interesting name of all, since it is called Alkaid or Benetnasch; the two names together meaning the "chief of the daughters of the Bier." It will be remembered that itself double. Epsilon Ursae Majoris marks very nearly the place of the radiant point of a shower of Ursid meteors, the date of which is the 30th of November. For those astronomers who add the opera-glass to naked-eye work, the three stars of the plough handle and their immediate neighbourhood offer many interesting fields. So, too, the feet of the Bear, the three pairs of stars to which we have already alluded, are also worth studying with this amount of optical aid. The fore foot is composed of Iota and Kappa, Lambda and Mu mark the next, Nu and Xi the last.

Beta and Alpha are, as is well known, commonly called the "Pointers," inasmuch as the straight line drawn through them leads us very nearly to the Pole Star, which is about the same distance from Alpha as Alpha is from Eta. The name given it, from its nearness to the Pole, Polaris, is so universally applied to it, nowadays, that there is little need to notice the many Arabic names which it has borne. An opera-glass, however, shows us other fainter stars yet nearer the Pole, of which the chief is Lambda Ursae Minoris, just on the limit of unassisted vision whilst Groombridge 1119 is fainter still. Three other stars visible to the naked eye may be mentioned as within [illegible] of the Pole: Cephei 51, a designation which it owes to Hevelius, as it lies within the boundaries of Ursa Minor as the constellation is usually drawn nowadays; Delta Ursae Minoris; and Bradley 3147. This little group of stars, though not attractive to the sight, is of the utmost importance astronomically, since its components enable the professional astronomer to test the accuracy with which his transit instrument points to the north at intervals of about two hours.

The Midnight Sky for London, 1901, January 5.

Beta and Gamma are the only two other conspicuous stars of the constellation. Beta was once the Pole Star, or at any rate divided the title rôle with Kappa Draconis, and hence bears the name Kochab, "The Star," that is to say, the Northern or Pole Star. Gamma is a wide double star to the eye, Al Farkadain, the "calves," usually written Pherkad on our globes.

The constellation is the seat of several of the minor radiants. In September, there is one from the neighbourhood of 51 Cephei; in April there is another from near Gamma Ursae Minoris.

Between the two Bears, and almost encircling the Lesser, is a long winding stream of stars, making up the constellation of the Dragon. It is certainly one of the most ancient of all, and is believed by many to be the crooked serpent of Job xxvi. 13. Alpha of this constellation, now generally called Thuban, i.e., Dragon, and situated midway between Gamma of the Lesser Bear and Zeta the Greater, was the original Pole Star of the heavens when the constellations were mapped out, a pre-eminence it must have held for over 2000 years. Within this constellation also is the pole of the ecliptic almost in the centre of the great loop made by the Dragon's folds.

At midnight on New Year's Day, the Dragon's head reaches down almost to the northern horizon, two bright stars, Gamma and Beta, marking the top of its head. Of these the more westerly is of a rich orange tint, and is the zenith star of Greenwich, and as such was specially observed by Flamsteed, Bradley, and Airy, the second of whom made his discovery of the aberration of light in connection with it. Three stars, Xi, Nu, and Mu, make up the jaw, Mu being at the snout. Nu, the faintest of the three, is an opera-glass double.

Why this constellation got its fearsome symbol is not clear. It is true that the Dragon or snake was amongst all ancient nations used to symbolise the powers of evil, of darkness, or of chaos. But that gives us no explanation why a constellation, far from being the least beautiful and conspicuous, has been chosen to convey this idea of darkness; still less why such a symbol should have been planted at the very crown of the celestial sphere.

From Epsilon in the Great Bear a line through Polaris leads us to a small constellation, yet one of the most easily recognisable in the sky, Cassiopeia, the "Lady on her Throne," her principal stars, five in number, suggesting a W freely scrawled. The constellation at this time is west of the Pole, the highest star is Epsilon, then following the other points of the W in order, we have Delta, Gamma, Alpha, Beta. The only stars of the five which in modern days are often referred to by their Arabic names are Alpha, Schedar or "Breast"; and Beta, Caph or "Hand," or possibly in some allusion to her husband Cepheus who stands by her side. The latter forms a larger but much less conspicuous constellation, lying between Cassiopeia and the Dragon, its four chief middle stars forming a lozenge; the point of the lozenge most remote from Cassiopeia is Alpha, Alderamin, the "right arm," the only one commonly referred to now by its Arabic name. Delta is one of the most interesting of the naked-eye short period variables.

Cepheus and Cassiopeia are especially interesting since they with three more southern constellations make up a recognised and unmistakable story pictured in the sky; a clear proof that the work of original constellation making was deliberate and not haphazard, and that the legends there represented were in existence before the star groups were made. Brown argues justly that Cepheus is manifestly a non-Hellenic sovereign. He is indeed often spoken of as Ethiopian, but the Ethiopia there meant is not Nubia or Abyssinia, but the Euphratean "Cush." Hence there is no justification for those too precise artists and poets who have represented poor persecuted Andromeda as a sable beauty, "black" if "comely."

Cassiopeia is a constellation that well repays opera glass scrutiny, and it also furnishes to the naked-eye astronomer several important meteor radiants, of which one from near Delta deserves especial notice, and it is an especial favourable neighbourhood in which to commence the study of the Milky Way, since the constellation passes through our English zenith. It is most famous historically from the appearance of the celebrated Nova of 1572—the "Pilgrim Star"—which formed very nearly the fourth point of the square, or rather rhombus, of which Alpha, Beta, and Gamma mark the other three points.

Camelopardus is a great straggling constellation, all the stars of which are faint, which lies between Ursa Major and Cassiopeia, and stretches upwards almost to the Pole.

Letters.

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

IS HUMAN LIFE POSSIBLE ON OTHER PLANETS?

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I have just come across a passage in Grant Allen's little book, "The British Barbarians," in which he states that "planetoscopists" are agreed that there is no form of living creature in any of the planets that can be called "human," because the physical conditions are in all probability so different from those on this planet that the life which probably does exist there, as here will have followed a very different course of development or evolution.

I should be very glad if you could inform me in KNOWLEDGE whether this statement of the views of those who have made a special study of the planets is correct. I had a notion that it was considered that the physical conditions of Mars (e.g.), so far as they can be known or guessed at, are so like those of this earth as to make it probable that human beings may be living there.

Of course I know that a scientific man would be very reluctant to commit himself to an opinion on a question for the solution of which there is so little evidence available as there is for this question of possible human life elsewhere than on this earth; and for that very reason I thought Grant Allen's statement was too definite and sweeping.

Churchstanton Rectory, ARNOLD D. TAYLOR.
Honiton, October 31st, 1900.

PHOTOGRAPHIC SEARCH FOR THE LEONIDS.

Mr. J. Maclair Boraston watched for the Leonids on November 14th, from 12h. to 14h.; 5 meteors were seen, 3 of them being Taurids, and 2 probably Leo Minorids. "The result was that no true Leonids appeared." Mr. Boraston also exposed a plate from 13h. 15m. until 14h. The star trails are not, however, true curves, but show slight irregularities, for which Mr. Boraston enquires the cause.

We have examined the photograph sent, and the irregularities are manifestly due to small motions of the camera.—E. W. M.

CONSTITUENTS OF THE SUN.

"Nemo" enquires whether the experiments of Prof. Janssen, conducted at the summit of Mont Blanc, has not proved that oxygen is wanting in the sun.

No; Prof. Janssen showed that the great absorption bands given by the oxygen in our atmosphere are not also given by absorption in the solar atmosphere. But the temperatures of the atmospheres of the two bodies are so entirely different that this is no criterion. It simply shows that oxygen does not exist in the sun at terrestrial temperatures.

"Nemo" also finds the prominences an extremely striking feature in the dark lines of calcium, as seen on a photograph of the solar spectrum, and asks "Is it not then safe to suppose that they are either wholly or partially due to incandescent calcium vapour instead of hydrogen, as it is usually stated?"

Certainly they are partially due to calcium, even largely so. But their striking relief on the H and K lines is due to the great breadth and darkness of the corresponding Fraunhofer lines of the solar spectrum. They are brilliantly seen on the hydrogen lines, notwithstanding that the dark lines of hydrogen by no means furnish so good a background for them.—E. W. M.

Notices of Books.

[illegible] conducted at the Allegheny Observatory and at Providence, R.I., by Prof. Frank W. Very. This research took its origin [illegible] suggested by Prof. Cleveland Abbe to Prof. Very in 1891, [illegible] whether absorption is the absolute inverse of radiation for gases. It deals with a subject intimately connected with that which Mr. W. E. Wilson takes up in his Daramona Observations, lately published, but whereas Mr. Wilson has to do with the radiation from gases at the enormous temperature of the sun's surface, Prof. Very tries to determine the absolute radiation in calories from a unit mass of gas at given temperature and density and at ordinary temperatures, not when burning, not when electrified, but when simply heated. The difficulties of the problem are very great, for, as Prof. Very says, "The investigator here is dealing with the invisible and the evanescent. In an optical apparatus a little stray light immediately attracts attention, and we proceed to trace it to its source with our eyes open. In our study of feeble invisible radiations, on the other hand, we grope in the dark, and only succeed in eliminating the unwelcome extraneous rays after innumerable trials and errors." It is quite impossible here to give any account of the methods of research or of all the results obtained; we must confine ourselves to but a few points which appear to bear directly on solar physics. As an absorbent of terrestrial radiation, aqueous vapour is very much more efficient than any other atmospheric ingredient; but as radiators when in large masses, the substances composing the atmosphere do not differ so widely as might be supposed, since the facility with which a highly radiative vapour parts with its heat is largely annulled by self-absorption in its deep layers of its own radiations, and since in gases heat is transferred from molecule to molecule with the greatest ease, it is the feebly radiative molecules which act as radiators, except in the comparatively thin outer layers. The depth of gas which gives maximum radiation at short range is an insignificant quality compared with atmospheric dimensions, and radiation from either the atmosphere of the earth or the solar chromosphere is a superficial phenomenon, even when the masses of heated gas measure thousands of miles in thickness. The fineness of the chromospheric lines in the solar spectrum, although the shifts of the Fraunhofer lines indicate pressures of many atmospheres at the base of the chromosphere, is a sufficient demonstration that only the outer layers radiate. Prof. Very also confirms and extends Mr. Evershed's results on the heating of iodine and its kindred vapours, that the light emitted by these glowing vapours appears to give a perfectly continuous spectrum while the corresponding absorption spectra are selective. "Thus there is no such close relation between emission and absorption as is implied by Kirchoff's law of radiating bodies. There seems, however, to be a general relation between the total absorbing and radiating power for the visible rays." These points seem to have a very close bearing on the question of the relation between the Fraunhofer and "Flash" spectra.

"THE RIDDLE OF THE UNIVERSE." By Ernst Haeckel. English edition. (Rationalist Press Association.) 6s. net. However unwilling we may be to accept some of the conclusions arrived at in this book, it is impossible not to admire the man who has written it. Towards the close of a life devoted to science he has, in "The Riddle of the Universe," summed up in popular form his views on all the great questions that affect mankind. His wealth of accumulated knowledge enables him to sweep from one great problem to another with astonishing ease and power. He first briefly summarises the evidence of evolution. Comparative anatomy and physiology [illegible] forbid us to separate man from the apes. Embryology [illegible] beyond a doubt that men have been by gradual stages evolved from a simple type of organism. After [illegible] the [illegible] of Darwin [illegible] of the Soul [illegible] writing [illegible] monism [illegible] in any form [illegible] The [illegible] from the body, nor the body apart from the [illegible] mortality of the soul [illegible] the very principle of monism. The [illegible] according to the law of [illegible] must be [illegible] energy. The sum of matter and the sum of force in the universe are unchangeable. The law of energy holds true in physiology. The growth, sensation, and movement of living organisms depend on the conversion of the potential energy stored in their food into kinetic energy. We now proceed to the monistic cosmogony. "The world, *i.e.*, apparently, the universe has no beginning and no end." The world and all living organisms upon it have been evolved. There is an absolute unity of nature. We cannot deny the affinity of the organic to the inorganic: the elements contained in both are the same. This monistic philosophy leads inevitably to Pantheism.

Even in Prof. Haeckel's statement of the theory of evolution there is much to criticise. He has not got rid of Lamarckism. Without even discussing the subject he decides that instincts are due to inherited habit, appealing to Darwin, though Darwin maintained that most instincts had quite a different origin. Moreover, we want to know on what lines evolution is proceeding among civilized races; whether, for instance, science and wealth are bringing about physical degeneration. On this he is silent. Intellectual freedom, he maintains, would bring about *progress in science and civilization*, but as to further *evolution* he is silent. He exaggerates the achievements of science. We know nothing about the origin of matter; yet he stoutly maintains that the universe has had no beginning. In the concluding pages, however, he speaks more reasonably: "We grant at once that the innermost character of nature is as little understood as it was by Anaximander." One more criticism. He attacks religion with an acrimony that is out of place in a scientific work. His hatred of it blinds him to the fact that the evolution of civilized man (of Professor Haeckel himself, with his strong love of truth and justice) would not have been possible without the alliance of religion with morality. A life of controversy has left its mark on Professor Haeckel. There are subjects on which he cannot touch without losing his patience, and sometimes even his dignity.

"THE ROYAL OBSERVATORY, GREENWICH: A GLANCE AT ITS HISTORY AND WORK." By E. Walter Maunder, F.R.A.S. (Religious Tract Society.) Illustrated. 5s.—To the public at large the Royal Observatory is forbidden ground, and we are therefore especially grateful for this authoritative account of our national observatory and its work. The story of the foundation and development of the Observatory forms an important chapter in the history of science, and it is here admirably told from first-hand sources in a popular manner, but with sufficient fulness to form a valuable work of reference. Commencing with the pathetic figure of Flamsteed—without assistance or instruments other than he chose to provide out of his meagre salary of £100 a year—the gradual acquisition of buildings, instruments, and staff under the rule of succeeding Astronomers-Royal is traced step by step; and, finally, the reader is conducted through the various departments as they exist to-day. Doubtless many who believe that to be a professional astronomer is to sit at the eye-end of a telescope and admire the glories of the heavens will be disillusioned on reading this book. The busy hive of workers, mostly employed in laborious calculations at their desks, forms quite another picture, but the author, who is so well known to our readers, has the skill to reveal the inner beauties of even this very serious side of astronomical work. It is made quite clear also that it is not to such an institution as that at Greenwich that we must look for "discoveries" in astronomical science, the aim being more especially to cultivate those branches of work which demand continuous observations extending over many years, and which cannot therefore be left to the efforts of amateurs. It is well to recall the fact that the Royal Observatory was founded primarily, and has since been maintained, for the strictly practical purpose of assisting navigation, by obtaining a better knowledge of the motions of the moon and of the positions of the stars for application to the determination of longitude at sea. Expansion in various directions, however, was inevitable, but assistance to navigation has always been the first object of the work of the Observatory. The book is brightly written throughout, and gives much valuable information in an unobtrusive way, not only with reference to this particular observatory, but on a great variety of astronomical subjects. It is beautifully illustrated, with portraits of the eight Astronomers Royal, and many photographs of instruments and observatories. To those interested in astronomy the book is an excellent substitute for a personal visit to the Observatory, and even those who may obtain the great privilege of a visit will find that they will see a great deal more by having first learned what to look for.

"PHOTOGRAMS OF THE YEAR 1900." Compiled by the Editors and Staff of the *Photogram* assisted by A. C. R. Carter. 3s. (Dawbarn and Ward.)—This comprehensive annual should be in the hands of every photographer, both for his pleasure and his profit. In its well-arranged pages are produced not merely a good display of all sorts of prints, but also articles by writers who are entitled to speak with authority. These articles are selected with the object of exemplifying opposite views of photography. Hence we have one writer, Herr Ernst Juhl, full of praise for "gum" printing, and expatiating on its possibilities in the hands of certain German workers. And, in direct antagonism, an article by Dr. P. H. Emerson, in which he vigorously condemns, not only "gum" printing but also "faking," and he apparently would allow no handwork at all. To this lack of agreement among experts we may obviously assign the variety of grotesque photographs which are accorded prominence in the annual exhibitions. Photographs which arrest the eye solely because they startle, are so frequently held up to admiration for their originality that the multitude of unhappy productions of this kind have already made "artistic photography" the laughing stock of artists. No better instance is wanted than that of a production labelled "In the Marshes," on page 15 of *Photograms of the Year*. But perhaps the fact that but few such prints are given in this book is a sign of increasing sanity in photography.

"STUDIES IN FOSSIL PLANTS." By Dukinfield Henry Scott, M.A., PH.D., F.R.S. Illustrated. (Black.) 7s. 6d.—Botanical readers have long since learned that anything which proceeds from Dr. Scott's pen demands their best attention. The volume before us, the latest addition to the rapidly increasing literature of "Fossil Botany," is, in every respect, up to the high standard which the author has attained in his previous works. Fossil plants, until recently, have received but slight attention from the botanist, and for the geologist they have had but little interest, except as characteristic marks by which certain strata can be recognised. Among living English botanists who have studied these records of the plant life of past ages, perhaps none have done more important work than the author of this volume, and he is, therefore, peculiarly qualified to present us with an account of the present condition of our knowledge of the subject. Taking for his text the classic phrase in which Count Solms-Laubach stated the object of the study of fossil plants, "the completion of the natural system," Dr. Scott records "those results of palæobotanical enquiry which appear to be of fundamental importance from the point of view of the botanist." These are found almost entirely in the two sub-kingdoms "Pteridophyta" and "Gymnospermæ," which alone are dealt with. The fossils considered are such as are "well-characterised"; more doubtful specimens being wisely disregarded. The treatment of the subject is exceedingly clear, and the work cannot fail to be of absorbing interest to the student of living plants who desires a stereoscopic view of the vegetable life of the globe. The capital illustrations which abound, show the remarkable fidelity with which even minute details of the structure of vascular plants have been preserved by petrifaction, and add considerably to the value of the work to the palæobotanical reader.

"REPORT OF THE KITE OBSERVATIONS OF 1898 BY THE DEPARTMENT OF AGRICULTURE, U.S.A."—The observations were made with Box Kites, at seventeen stations in North America. The mean rate of diminution of temperature with increase of altitude, as determined from 1217 ascensions and 3838 observations, taken at elevations of 1000 feet or more, was 5.0° for each 1000 feet. The largest gradient, 7.4° per 1000 feet, was found up to 1000 feet, and thereafter there was a steady decrease up to 5000 feet, the rate of decrease becoming less as the altitude increased. The relative humidities at and above the earth's surface differed little except at 7000 feet, where the surface humidity was 11 per cent. less than that above. There was a steady but by no means uniform decrease of vapour pressure with increase of altitude.

"Annual Report of the Paris Observatory."—Of late years the Paris Observatory has given in each annual report a very beautiful and practical specimen of the work accomplished, in a heliogravure of the moon, photographed by MM. Lœwy and Puiseux, with the Grand Equatorial Coudé. The plate this year was taken on 1899, February, 6d. 16.5h., when the moon was aged 6d. 8.8h., and the Mare Serenitatis was half in shadow, its western wall showing very dimly against the sky. The chief point of interest, indeed, in the report, relates to the great lunar photographs, and especially to the giant presentations of 1.38m. of the moon in the first and last quarter, exhibited at the Paris Exhibition. Besides the work of the great lunar atlas, and the other routine observations, connected with the meridian and astrographic departments, M. Hamy has conducted a series of interference measures with the object of determining the wave-lengths of a certain number of standard points in the spectrum.

"The Path of the Sun: Its Orbit and Period of Revolution Demonstrated." With an Exposure of the Fallacy of the Precession of the Equinoxes. By William Sandeman, F.C.A. (Simpkin.)—The phenomena produced by the rotation of the earth on its axis in 24 hours, could also be explained by a rotation of the entire heavens on a similar axis in a similar time. So the phenomena produced by the revolution of the earth round the sun in a year could also be produced by the revolution of the sun round the earth. We have plenty of paradoxers to uphold both doctrines. The gross improbability of their assumptions does not strike them, and they are either ignorant of those facts which are irreconcilable with their theories, or they have not sufficient discernment to see how they bear upon them. Mr. Sandeman falls into an error, precisely analogous in its character, but dealing with a somewhat more recondite question. He refers the rotation of the axis of the earth in the precessional cycle of nearly 26,000 years to a revolution of the sun and the entire solar system in a similar period. The paradox is therefore practically the same in nature as those with which the "flat-earth" and the "immovable-earth" people have made us so familiar.

"Annals of the Lowell Observatory," Volume II.—The second volume of the "Annals of the Lowell Observatory" is like the first, sumptuously prepared and fully illustrated. It deals with the two planets Jupiter and Mars: the first was observed in 1894 and 1895, the latter in 1896 and 1897. The observations of Jupiter itself dealt with the polar flattening, which was found to be 1/16.41, and with refraction in its atmosphere. The amount of refraction found was considerable, namely a refraction of 8′ of arc in the outer atmosphere. The depth of the atmosphere would appear to be great—2800 miles is suggested—with a slow decrease in the refractive power and density. But much more attention was given to the satellites, of which a great number of beautiful little drawings are given. Of the satellites, the first was considered to be markedly elliptical, being a prolate spheroid, revolving end over end about one of its minor diameters in a period of 13 hours. Of satellite II., little could be made out. The third satellite showed a slight ellipticity, but several surface details were detected, which may be described as a northern belt, crossed occasionally by another line or belt, rarely a central forked belt, and once a southern belt. The fourth satellite also showed a slight ellipticity. Both third and fourth satellites kept the same face always turned towards their primary, whilst the rotation of the first satellite was much more rapid than its revolution. The greater part of the volume is, however, given to the planet Mars, and the researches detailed in the first volume of the "Annals" are continued in this. The meteorology of Mars, it is inferred, resembles that of our own earth, except in so far as they are affected by the limited water supply. There appears to be a great transference of moisture from one hemisphere to the other, twice in the course of the Martian year, chiefly by an aerial transmission. "Radiation and polar clouds are the more common forms on Mars, cyclonic and conventional clouds are very rare." The observers are inclined to ascribe many of the dark markings to vegetation. "The surface of the planet seems likely to be level, but large raised areas exist in the polar regions. . . . The mean temperature at the poles is likely to be not far below freezing, the contrast between day and night is considerable." Whatever reluctance may be felt to accept the conclusions of the Lowell observers in their fulness, there can be no question that the principle they [illegible] of making these planetary observations as continuous as possible, and not spasmodically, is the right and true one. It is the only method, and it is a certain one, for making sure [illegible] progress in our knowledge of the conditions of the planets.

"Williams and Norgate's Book Circular."—We have received a most useful volume from Messrs. Williams & Norgate, comprising eight monthly issues of their *Book Circular*. This publication contains well written and critical notes on new and forthcoming books, chiefly Continental. It should be of considerable value to scientific workers.

Catalogues.—We have received useful catalogues of electrical apparatus, from Messrs. W. & J. George, Limited; of microscopes and microscopic slides, from Mr. C. Baker; of cabinets, birds' eggs and skins, butterflies and moths, from Messrs. Watkins and Doncaster; of bioscopes and of cinematograph films, from the Warwick Trading Company, Limited; a pamphlet on the Kammatograph, from Messrs. Kamm & Co.; a Radiographic list from Messrs. Isenthal & Co.; and supplementary list of lantern slides from Messrs. Newton & Co.

BOOKS RECEIVED.

The Progress of Invention in the Nineteenth Century. By Edward W. Byrn. (New York: Munn & Co.) Illustrated. $3.

Report on the Census of Cuba, 1899. (Washington: Government Printing Office.)

Railway Runs in Three Continents. By J. T. Burton Alexander. (Elliot Stock.) 7s. 6d. net.

Botany: An Elementary Text for Schools. By L. H. Bailey. (Macmillan.) Illustrated. 6s.

Botany. By R. S. Wishart, M.A. (The Self-Educator Series.) (Hodder and Stoughton.) Illustrated. 2s. 6d.

The Self-Educator in French. Edited by John Adams, M.A., B.SC. (Hodder & Stoughton.) 2s. 6d.

One Thousand Objects for the Microscope. By M. C. Cooke, M.A., LL.D., A.L.S. New Edition. (Warne.) Illustrated. 2s. 6d.

All Change. By Wilfred Woollam, M.A. (Elliot Stock.)

What is Heat? and What is Electricity? By Frederick Hovenden, F.L.S., F.G.S., F.R.M.S. (Chapman & Hall.) Illustrated. 6s.

A New Practical Method of Learning French Colloquially. By L. B. Meunier. (Philip & Son.) 2s.

The Structure and Life History of the Harlequin Fly. By L. C. Miall, F.R.S., and A. R. Hammond, F.L.S. (Clarendon Press.) Illustrated. 7s. 6d.

Hand-Book of Practical Botany. By Dr. E. Strasburger. Translated by W. Hillhouse, M.A., F.L.S. 5th Edition. (Swan Sonnenschein.) Illustrated. 10s. 6d.

The Romance of the Earth. By A. W. Bickerton. (Swan Sonnenschein.) Illustrated. 2s. 6d.

A School Chemistry. By John Waddell, B.A., B.SC. (Macmillan.) Illustrated. 4s. net.

By Land and Sky. By the Rev. John M. Bacon, M.A., F.R.A.S. (Isbister.) Illustrated. 7s. 6d.

Annuaire Astronomique, 1901. Par Camille Flammarion. (Paris: Flammarion.) Illustrated. 1fr. 25.

Table of Divisors. By Thomas Dence. (Mayfair Works.)

The Complete Works of John Keats. Edited by H. Buxton Forman. Vol. I. (Glasgow: Gowans & Gray.) 1s. net.

Table Générale des Publications de la Société d'Anthropologie de Paris. (Paris: La Société d'Anthropologie.) 6fr.

The Story of Thought and Feeling. By Frederick Ryland, M.A. (Newnes.) 1s.

Jewellery and Trinkets. By Alice Teague. (Dawbarn & Ward.) Illustrated. 6d. net.

The Heavens at a Glance, 1901. Card Calendar. By Arthur Mee, F.R.A.S. 7d. Post free.

The Story of Nineteenth Century Science. By Henry Smith Williams, M.D. (Harper and Brothers.) Illustrated. 9s.

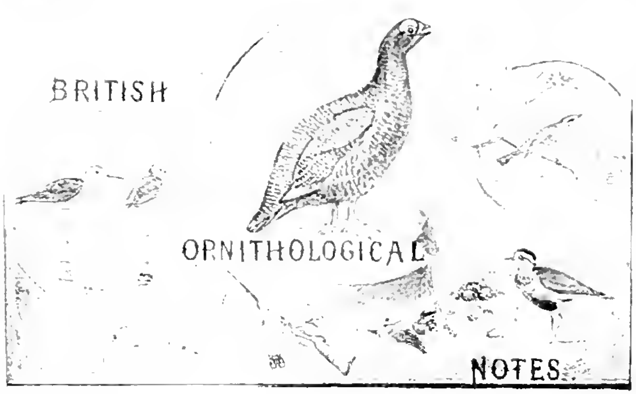
The Principles of Magnetism and Electricity. By P. L. Gray, B.SC. (Methuen & Co.) 3s. 6d.

Lord Lilford: A Memoir by his Sister. (Smith, Elder & Co.) Illustrated. 10s. 6d.

Practical Lessons in Metal Turning. By Percival Marshall. (Dawbarn & Ward.) Illustrated. 2s. net.

Who's Who, 1901. (A. & C. Black.) 5s. net.

Englishwoman's Year Book. (A. & C. Black.) 2s. 6d. net.



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

BIRD MIGRATION IN GREAT BRITAIN AND IRELAND.—At the meeting of the British Association in 1896, it will be remembered that the Bird Migration Committee published a most important Digest of the Observations on the Migrations of Birds at Lighthouses and Light-vessels from 1880 to 1887.* This Digest was the work of Mr. W. Eagle Clarke. Important and satisfactory as it was, it was only considered as the foundation for future work. Undaunted by the magnitude of his task, which cannot be exaggerated, Mr. Clarke has not only continued his work of systematically tabulating the 100,000 records of the lighthouses, but he has added to this mass of facts many more thousands of observations culled from the voluminous literature published during the period covered by the enquiry. Four years of incessant toil since the publication of the Digest enabled Mr. Clarke to gather, sift, and arrange, in conjunction with the lighthouse reports, this additional matter, so that the data being now as complete as possible, "the time has arrived when, for the first time in the annals of British Ornithology, it is possible to write an authoritative history of the migration of each British bird." And not only is this possible, but we believe that Mr. Clarke has so far advanced this most important and valuable work that its publication will not now be long delayed. As examples of his method of treating the subject, Mr. Clarke furnished the British Association last year with a summary of details of the various migratory movements of two species—the Song Thrush and the White Wagtail. The following brief abstract of one of these may interest those who have not had an opportunity of reading the original paper:—

THE MIGRATIONS OF THE SONG THRUSH. The Song Thrush furnishes a most excellent example of the complex nature of the phenomena of bird migration as observed in Great Britain and Ireland. Its various movements cover a period of nearly ten months of the year. Throughout August and more especially in September and October many Thrushes, which have bred here, move southward to winter in warmer climes. At the end of September and during the whole of October great numbers of Thrushes from North-Western Europe invade the north-east coast of Great Britain. Of these foreign-bred birds many proceed south and finally quit our shores, the majority to seek more southern lands, but others to winter in Ireland. Others, again, remain as winter visitors in England. This immigration of Thrushes from the Continent, unlike that of other species, ceases with the month of October. In the winter (from October to February) we have a different kind of migration. These movements are entirely due to outbursts of cold or bad weather. At such times immense numbers of Thrushes, both residents and intending winter visitors, rush to the coasts, along which they proceed south and west. If the cold continues many leave the country altogether, while others find refuge in Ireland. During February and March our own Thrushes, which left us in the autumn to winter in the south, gradually begin to return. Towards the end of March the Thrushes which have wintered in the islands off the west of Scotland and Ireland take their departure for Northern Europe. Throughout April those that have wintered in the mainland depart as they came, *via* the north-east coast of England and the east of Scotland. Merged somewhat with this latter movement are the travellers which pass during April and occasionally in May along our eastern seaboard on their way from the south to the north of Europe.

These are the main points in the complicated migratory movements of the Song Thrush in Great Britain. All ornithologists will heartily agree with the Migration Committee that "A great debt of gratitude is due to Mr. Clarke for the courage and perseverance which he has shown in grappling with the enormous mass of statistics necessary to afford the results so lucidly and concisely summed up by him."

BAIRD'S SANDPIPER IN SUSSEX.—A NEW BIRD TO THE BRITISH LIST.—At the meeting of the British Ornithologists' Club, held on November 21st, 1900, Mr. Ernst Hartert exhibited a young female specimen of Baird's Sandpiper (*Heteropygia bairdi*). The bird was shot at Rye Harbour, Sussex, on October 11th, by Mr. M. J. Nicoll. Mr. Nicoll wrote that the flight was like that of the Common Sandpiper for the first few yards, then the bird rose straight in the air for a considerable height, and then dropped suddenly towards the ground. It did this every time it was flushed. Its cry was a shrill twitter, different from that of any British species. The bill and legs were jet black. Baird's Sandpiper is an American species.

BRITISH FORM OF THE WILLOW TIT (*Parus salicarius*).—In KNOWLEDGE for April, 1898, p. 81, we drew attention to this bird, which Mr. Hartert introduced to the British list from specimens obtained at Finchley. At the November meeting of the British Ornithologists' Club, Mr. Hartert announced that he had found a specimen in the collection of Mr. Ticehurst, from St. Leonards, and had recently received fresh skins from Mr. Ruskin Butterfield, from Hastings. The bird would no doubt be detected in other localities, when British ornithologists were able to distinguish the Willow Tit, with its dull head, from the ordinary Marsh Tit with its glossy crown. Ornithologists will do well to carefully observe Marsh Tits, in the hope of distinguishing the Willow Tit, and thus obtain more evidence regarding the bird in Great Britain. There is a little difficulty about the name of the bird. For those who accept trinominals and unite all the dull-headed forms of the Grey Tits, the Continental Willow Tit would be *Parus montanus salicarius*, and the British form *Parus montanus Kleinschmidti*; otherwise the British Willow Tit might be called *Parus Kleinschmidti*, since it differs from the Continental form by being slightly smaller and more richly coloured. Those who do not recognize the slight differences of the Continental and British forms of the Tits as worthy of specific rank should call the bird *Parus salicarius*, and in taking Mr. Saunders' Manual as the standard book on British birds, and following his decisions regarding the Long-tailed Tit and the Coal Tit, we are inclined to call the Willow Tit simply *Parus salicarius*.

* For Summary of this Digest *see* KNOWLEDGE, November 1896, pp. 254—256.

The Birds of Yorkshire.—The Honorary Secretary of the Yorkshire Naturalists' Union announces that Mr. T. H. Nelson has undertaken to continue and complete Mr. W. Eagle Clarke's work on the "Birds of Yorkshire," which has been partly published in the *Transactions* of the Yorkshire Naturalists' Union, and the continuation of which was interrupted by Mr. Clarke leaving Yorkshire to settle in Edinburgh. Considering the length of time that has elapsed, and the number of records and observations of Yorkshire birds which have accumulated since Mr. Clarke wrote his last instalment of this work, we think it unwise to continue the publication. Good as we know Mr. Clarke's work to be, such revision is required in bringing it up to date that nothing short of re-writing would be satisfactory. Moreover, Messrs. Oxley Graham and James Backhouse have long been engaged on a work on the birds of Yorkshire, the manuscript of which we understand is now nearly complete.

Pectoral Sandpiper at Aldeburgh (*Zoologist*, November, 1900, p. 521). Mr. E. C. Arnold records that he shot a specimen of *Tringa maculata* on September 13th last at Aldeburgh, Suffolk. This bird has occurred in England more frequently than any other American wader, and has already been recorded four times from Suffolk.

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 INSECTS OF THE SEA.

By Geo. H. Carpenter, B.Sc. (Lond.), *Assistant in the Museum of Science and Art, Dublin.*

INTRODUCTORY.

Marine insects have been somewhat neglected both by entomologists and by students of the "common objects of the sea-shore." An ardent insect-hunter will quickly fill his boxes, as he wanders over the hillside, or sweeps along the thick undergrowth of the woodland, while hours of work along the tidal margin may yield him but a few obscure flies and beetles. And the naturalist who finds especial delight in the rock-pool or the wave-swept beach, is usually so engrossed with his shells or his zoophytes that he does not notice the insects lurking beneath the stones or crawling among the seaweed. Hence so keen a naturalist as the late P. H. Gosse* told his readers forty-five years ago that "of the hundreds of thousands of insects known to exist but *two* live in the sea." Even at that date the statement was much under the mark. Leach, Guérin, and Haliday had years before detected and described many of the shore-haunting insects which will be mentioned at length hereafter; while as early as 1822, Eschsholtz had made known the wonderful bugs of the genus Halobates, the only insects whose whole life is spent on the open sea. In 1871, A. S. Packard† mentioned some dozen marine species from the Atlantic and Pacific coasts of North America. References to marine insects in the works of recent writers—Moniez‡ and Miall§ for example—show that some scores of kinds probably occur on our own coasts, most of the important orders being represented. And it is likely that the marine insects of the whole world will be found to number some hundreds of species.

Still the insects of the sea seem but an insignificant group when we compare them with the well-nigh countless kinds of insects that inhabit the air and the land, two millions according to the lowest recent estimate, and ten millions if we may accept the opinion of so careful a naturalist as the late C. V. Riley. Hundreds only as compared with millions! It might easily be thought that marine insects are unworthy of the naturalist's attention. Yet their poverty in numbers is really a sign of the value of the study; creatures so few in comparison with their class as a whole must have something exceptional about them, and their form and life-history must yield results of high interest to the patient enquirer.

Insects are pre-eminently creatures of the air and the land. The power of flight possessed by most insects, the wonderful system of branching tubes found in almost all—carrying air to all parts of the body so that oxygenation of the blood goes on everywhere—mark them out as essentially a class of air-breathing animals. It is well known that many insects pass the earlier stages of their life-history in streams and ponds, but comparatively few of the grubs have acquired the power of breathing the air dissolved in water. Most aquatic larvæ, and all the insects which live in water when adult, have to come into touch with the upper air when they want to breathe. Prof. Miall's fascinating work on aquatic insects, to which reference has already been made, is largely occupied with descriptions of the wonderful adaptations whereby a supply of fresh air is secured to these dwellers in the water. Since insects, then, are so characteristically children of the air it is of special interest to find that some have established themselves close to, in, or on the waters of the sea. The immense number of different kinds of insects must make the struggle for life among them exceptionally severe, and the existence of marine insects is a striking proof of the hardship of the struggle. They have been driven to adapt themselves to life in salt water, just as thousands of the teeming human population of China have been driven to live in house-boats and junks.

The insect-fauna of the land and the freshwaters merges gradually into that of the sea. Many genera of aquatic insects have species which live in brackish water. There are many kinds of beetles, flies, and moths, rarely or never found elsewhere than on coast sand-dunes. These, however, live high and dry, and may be fairly regarded as terrestrial species. Nearer the water's edge, where the blown-sand passes into the beach, a row of blackened seaweed marks the limit of the high spring tides. In this a number of beetles may often be found; over it hover flies whose grubs are feeding in the decomposing mass below, and they must be able to bear at least occasional immersion. Right down by the water's edge, along the margin of the rock-pools, lurking in the seaweed covered twice daily by the waves, skimming over the surface-film, or swimming through the clear, calm water when the tide is out, the true marine insects must be sought for and studied. Still more daring invaders of the sea may be observed by the sailor-naturalist in tropical climes. He will find some relations of our common pond-skaters, skimming over the waters of estuaries or harbours where his ship lies becalmed, and he will meet with others on the open ocean hundreds of miles from land.

Our survey of the insects of the sea will best be taken order by order. The representative of the most primitive of the orders—the Bristle-tails (Thysanura)—may appropriately come first; though it lives close to the water's edge, it seems rarely or never to be covered by the tide.

BRISTLE-TAILS.

The marine member of the order Thysanura is the

* "Manual of Marine Zoology for the British Isles." Part I. p. 178. London, 1855.

† "On Insects inhabiting Salt Water." *Amer. Journ. Sci.*, 1871; *Ann. Mag. Nat. Hist.* (4), VII., pp. 230-240.

‡ "Acariens et Insectes marins des Côtes du Boulonnais." *Rev. Biol. Nord, France*, II., 1889-90.

§ "The Natural History of Aquatic Insects," London, 1895, ch. XII.

insect which was described by Leach in 1815 as *Machilis maritima*. These Bristle-tails may be found in numbers around the rocky parts of our coasts, sometimes lurking under stones, sometimes disporting themselves in the sunshine on the smooth sides of a rock-pool. They can run with a swift, gliding motion over the surface of the rock, and are able to leap nimbly when disturbed. Without reckoning the long feelers and tail bristles, *M. maritima* measures about 12 mm. (½ inch) in length (*see* Fig. 1).

The structure of Bristle-tails is of great interest to naturalists, since these insects have retained a number of primitive characters. They remain wingless throughout life, and they are especially remarkable in having paired limbs on several of the hind-body (abdominal) segments. It is believed, therefore, that they represent to some extent the far-off, many-legged, ancestors of our present-day six-legged insects. In Machilis these abdominal limbs (Fig. 1, II.-X.) are more numerous than in any other genus of the Thysanura, being present on all the segments, from the second to the tenth inclusive. Those borne on the tenth segment are the long, jointed, bristle-like organs, known as cercopods, which are to be seen also in some winged insects—mayflies and stoneflies, for example.

But a point in the structure of the Machilis suggests that though these abdominal limbs may tell us of ancestral forms with many pairs of legs, yet they do not correspond exactly with the six legs of the thorax. The haunch in the second and third pairs of legs in Machilis carries, in addition to the functional legs, a small pointed hairy appendage (Fig. 1, 2-3), which agrees closely in form and size with the abdominal limbs. It seems, likely, therefore, that two-branched limbs occurred on all the segments in the ancestral form, and that the inner branch persists as the functional limb of the thorax in insects generally, while the outer is preserved in the abdominal appendages of the Bristle-tails.

Close to these limbs we find small bladder-like sacs, which can be withdrawn (Fig. 1, *b*) or pushed out (Fig. 1, B), at the will of the insect. There is a pair on each of the first, sixth, and seventh abdominal segments, and two pairs on each segment from the second to the fifth inclusive. J. T. Oudemans,|| to whose researches we owe most of our knowledge about *Machilis maritima*, gave much attention to the structure and probable use of these organs, and came, somewhat doubtfully, to the conclusion that they have a respiratory function. When thrust out, they contain blood, and they might well be used to absorb air in damp situations. But Machilis breathes also, like the higher insects, by means of air-tubes. These open to the exterior by paired air-holes (stigmata) on the two hindmost thoracic segments and the second to the eighth abdominal segments inclusive. The branching systems of tubes leading from the various air-holes remain separate; they do not, like those of the winged insects, unite to form continuous trunks and networks.

Like some other Bristle-tails—the well-known "Silver Fish insect" (*Lepisma*) of our houses, for example—Machilis is covered with scales, resembling those found on the wings of moths and gnats. The scales of Machilis (Fig. 3) are of large size, about .1 mm. in length, and are stiffened with thickened rod running lengthwise; between these, short transverse markings can be distinguished arranged like the rungs of a ladder. The scaly covering of *Machilis maritima* gives to the insect during life a dark mottled aspect, which often agrees closely with the appearance of the rocks among which it

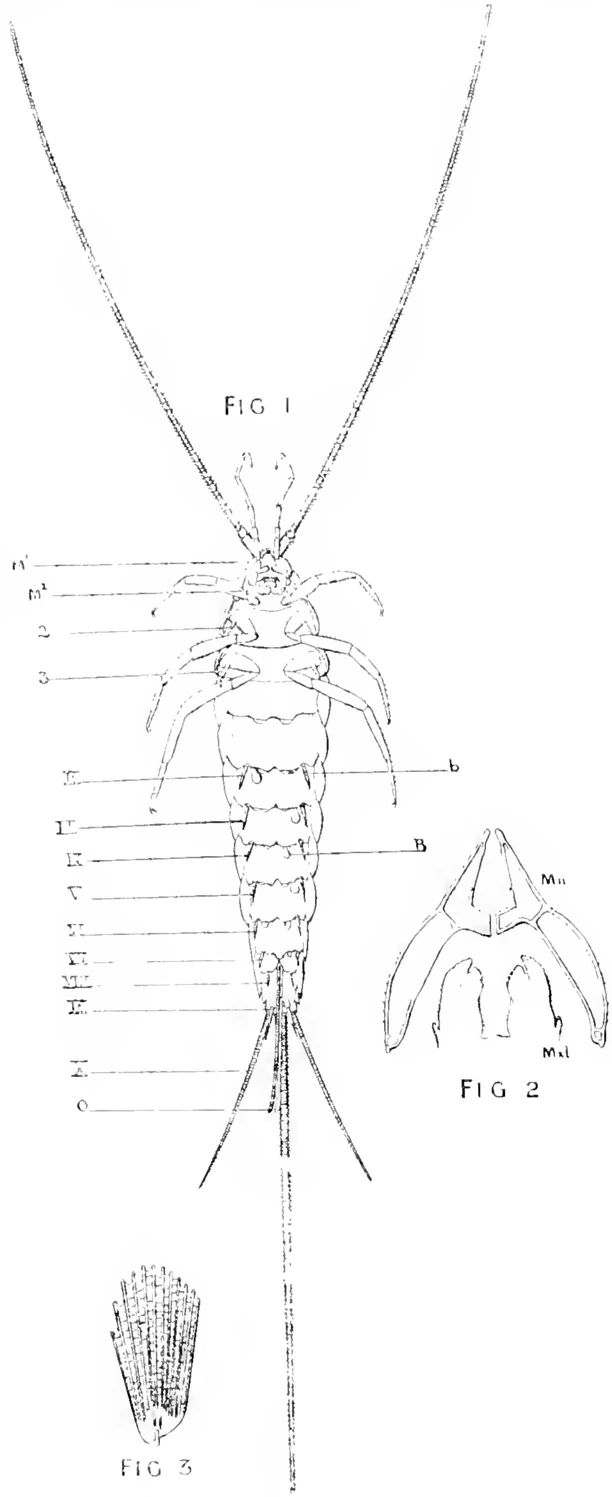


FIG. 1.—*Machilis maritima*, Leach. Female seen from the Ventral Aspect. M¹, M², first and second pairs of maxillæ; 2, 3, appendages on haunches of second and third legs; II.—X., limbs on abdominal segments; O, ovipositor; B, protruded, and b, withdrawn bladder-like sacs on abdominal segments. Magnified 5 times.

FIG. 2.—Mandibles (Mn.), and Maxillulæ (Mxl.) of Hansen ("paraglossæ" of most authors) dissected out of the head. Magnified 20 times.

FIG. 3.—A Scale from the Back. Magnified 25 times.

|| "Beiträge zur Kenntniss der Thysanura und Collembola." *Bijd. tot de Dierkunde* (Amsterdam), XVI., 1888, pp. 147-227, pls. I.-III.

lives. Similar protective colouring is to be seen in our other British species—*M. polypoda* (Linn.)—which is often abundant in stony places in the hill countries.

For our knowledge of the habits of *Machilis maritima*, as of its structure, we are chiefly indebted to Oudemans. He observed the insects carefully on the Dutch coast, where they frequent the stones of dykes and sea-walls, and the wooden piles of sluices. From May to November they are very lively, and often wander about singly. "It seems," he writes, "that they greatly like warmth. I have seen them on a hot August day run and leap very briskly on the hot stones of a dyke." In winter they withdraw into holes and chinks, where they crowd together in great numbers. Only full-grown individuals are to be seen in autumn and winter, but both adults and young in midsummer, whence it follows that the young are hatched in spring, and that the insects live for more than a year. "They are," writes Oudemans, "very inquisitive. If I approached a place (except in winter time) where they were to be found they usually came to the light. Did I approach too near, they began to run and jump about. If they fall into the water it does not matter, since they are hardly wetted thereby. They can move over the surface-film of the water, and even make short leaps thereon. Usually they reach the shore again after a short time, or find an object up which they can climb. I have often seen this." He goes on to describe how he kept specimens in captivity on the surface-film of water in a glass vessel up whose smooth wall they could not make their way. "They remained there forty-eight hours. When, afterwards, I gave them a chance of regaining dry land, they took the opportunity, and were perfectly right again after a few moments." It seems, therefore, that Machilis is well enough adapted to a life by the sea-shore. They appear to feed on vegetable refuse, but, like many creatures higher in life's scale, they fast during winter.

No one can examine Machilis without being struck by its general likeness to some other, and more familiar, creatures of the sea-shore—the sand-hoppers and their relations belonging to the crustacean order Amphipoda, which have lately been so ably described in these columns by Mr. Stebbing. Everyone knows that the Crustacea form a class of animals distinct from the Insecta, yet both classes are included in the great Race of jointed-legged animals or Arthropoda. Very diverse opinions have prevailed among zoologists as to the relationship between insects and crustaceans. It was at one time thought that the Bristle-tails, the most primitive of insects, as well as the crustaceans, could be traced back to an ancestral form resembling the well-known zoëa-larva of a crab.* Of late years, however, less importance has been attached to larvæ as indicative of relationships, and the view that there is but little connection between insects and crustaceans has been gaining ground.** But quite recently the problem has been attacked from a fresh point of view, and a rather close relationship between the Bristle-tails and the lower malacostracous Crustacea—the Amphipods and Isopods—has been advocated by the Swedish zoologist Hansen.††

It is well known that a typical insect, like a cockroach or a beetle, has three pairs of jaws—a pair of mandibles and two pairs of maxillæ, the second of which are more or less completely fused together to form a "lower lip" (*labium*). In Crustaceans we also find a pair of mandibles and two pairs of maxillæ, but in the Amphipods and Isopods the next pair of limbs, the first jaw-feet or maxillipeds, are also included in the head region, and become partially joined to form a "lower lip." Now Hansen has suggested that a pair of structures found in the head of the Thysanura, united basally with the tongue, especially well developed in *Machilis* (Fig. 2, Mxl.), and situated between the mandibles and maxillæ, are in reality a pair of jaws which correspond with the first maxillæ of crustaceans. If this view be correct, there are four pairs of jaws in the Bristle-tails, and the correspondence of these insects with the sand-hoppers, woodlice, and their relations becomes remarkably close, especially when we remember that the number of segments behind the head is exactly the same (thirteen) in both groups. Hansen states that vestiges of these "maxillulæ" are to be found in the cockroach and other insects; the Bristle-tails, therefore, seem to have retained a pair of jaws which the higher members of the class have almost or altogether lost. The mandibles of the Thysanura, too (Fig. 2, Mn), have many points of likeness to those of crustacea. Another correspondence with the sand-hoppers and woodlice is brought out by Oudemans, who states that the eye in Machilis as in those crustaceans has a layer of hypodermis-cells between the corneal facets and the crystalline cones.

As we watch *Machilis maritima* disporting itself around the rock-pools, the enquiry is suggested as to the various coasts which it haunts. All around the shores of our own islands—even to the remote Orkneys and Shetlands, as well as the Irish Aran—it has been found; as also on the rocky coasts of Norway, of Holland, of France, and Spain, and even on the Canary Isles lying out in the Atlantic off the shores of North Africa. It does not seem to range to the eastern European coasts.

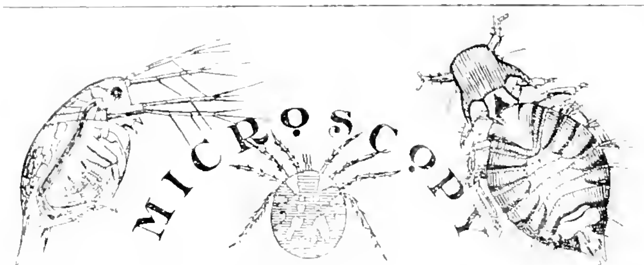
So far as we know, Machilis is incapable of crossing a sea-channel of any breadth. Its presence on these various western continental and island shores tends to show, therefore, that at some former period there must have been a continuous continental coast-line along which it could migrate. This humble insect furnishes one of the many distributional facts which point to the existence in Tertiary times of continental land lying north and south along the western margin of the present European area. And its presence on the Canaries lends support to the view—once highly popular, then discredited, now beginning again to find upholders—that this old western continent may have stretched away far into the Atlantic.

The mere fact that our little Bristle-tail haunts these rocky coasts calls up visions of a vanished continent, and shows how land and sea areas have changed in the course of the earth's history. And when we study the structure of the insect we are carried back to a past still more remote. As we see a Machilis gliding over some ancient Archæan rock, we imagine the primaeval sea in which the fragments of that rock gathered as sediment. In that same sea, maybe, lived the far-off common ancestors of the insects and crustaceans of to-day. No "record of the rocks" preserves the form of these primitive arthropods for our study; but we can guess at their nature by help of those characters which, passed on through countless generations of living creatures, still survive in our marine Bristle-tail.

* E. Haeckel. "The History of Creation." London, 1876.

** F. W. Hutton and others. "Are the Arthropoda a Natural Group?" *Natural Science*, Vol. X., 1897, pp. 97–117.

†† "A Contribution to the Morphology of the Limbs and Mouth Parts of Crustaceans and Insects." *Ann. Mag. Nat. Hist.* (6), XII., 1893, pp. 417–434. *See also Nat. Sci. (loc. cit.)*, pp. 103–5.



Conducted by M. I. Cross.

STANDARD SIZES FOR EYEPIECES.—On December 20th, 1899, the Council of the Royal Microscopical Society adopted certain internal diameters of draw-tubes as standards for eyepiece sizes: withdrawing those which had been fixed by them in the year 1882, which were two in number, viz.: ·92 in. for small stands, and 1·35 in. for large.

The following were the sizes decided upon:—

No. 1, ·9173 inch = 23·300 m/m.
" 2, 1·04 " = 26·416 "
" 3, 1·27 " = 32·258 "
" 4, 1·41 " = 35·814 "

A year has gone by, and it is now possible to estimate the value of these fresh gauges and to ascertain the probability of their regular and general use. We are indebted to the courtesy of manufacturers for statements of their intentions on the subject, and although several have abandoned old sizes for the new ones, or intend to do so, there yet remain some who do not seem disposed to consult the public convenience by falling into line. It will be apparent that No. 1 gauge is the one known as the "Continental size," and is practically the same as the smaller gauge recommended by the Royal Microscopical Society in 1882. This is almost the universal diameter for student's microscopes, and its popularity shows no likelihood of diminishing. The No. 2 gauge is differently placed, and it is not unanimously agreed that its inclusion in the list is either necessary or advantageous. The number of microscopes in which this is likely to be used is extremely limited. The No. 3 gauge is very suitable for stands of medium size, but No. 4 is of questionable value, for the day for the large models to which this gauge would be applicable seems to have passed. All considered, it would seem that both the public and the manufacturers would have been better placed had three sizes only been fixed, and in view of present knowledge and experience, a confirmation of the sizes of 1882, with the addition of an intermediate gauge, say the one of about 31 m/m., which was already in regular use, would have been a very convenient and acceptable range. The net result will probably be, as time goes on, that gauges Nos. 1 and 3 will become the standards, and it is to be hoped for the sake of uniformity that No. 2 at least may be withdrawn. The fewer the number of gauges the better for everyone. The prevailing tendency is to have a large tube, and with a fitting at the eyepiece end to receive eyepieces of the No. 1 gauge: after all, if the body be of sufficiently large diameter for photography, it does not matter greatly whether the eyepiece be large or small, for only in the oculars of *very* low power can a large field lens be used in the eyepiece. We are informed that a general meeting of German microscope manufacturers is shortly to take place, and it is possible that some consideration may be given to the recommendations of the R. M. Society on the subject of both eyepieces and sub-stage fittings. Universal sizes are of such prime importance that it is to be hoped that the random system which has too long prevailed, of every maker being a law unto himself, will be unknown in the future, and as workers realise that the standard sizes are an actual fact, they will insist on their incorporation in their stands, and so induce those makers who might otherwise be disinclined to alter the diameters of their tubes voluntarily, to meet the exigencies of modern work by using only the universal fittings of the Royal Microscopical Society.

BLOOD EXAMINATION.—In recent years the examination of blood for diagnosis of diseases, especially those peculiar to tropical climates, has assumed great importance, and every practical suggestion which enables it to be more thoroughly performed is welcome. We have had sent to us the description of a method devised by Dr. W. L. Braddon, of the Malay Peninsula, which is both interesting and effective. The corpuscles are examined in a film between (1) two square cover-glasses joined together, or (2) a square cover-glass attached to a 3 in. by 1 in. slide. Slides and cover-glasses are first of all sterilized by the method recommended by Messrs. Pakes and Howard, which is as follows:—The cover-glasses are dropped, *one by one*, into a 10 per cent. solution of chromic acid, contained in an enamelled iron dish, and boiled for twenty minutes. They are then tipped altogether into a shallow basin, and washed with ordinary tap-water, until all trace of the yellow colour of chromic acid has disappeared. The water is next poured off and the slips are covered with rectified spirit. After this they are washed in absolute alcohol, and handled with clean forceps." These cover-glasses and slides are then dealt with as follows:—

Method No. 1.—Two square cover-glasses are accurately superposed and firmly pressed together. An edging of vaseline if for temporary purposes, or cement if for permanent purposes, is laid over all the edges, except one, which is left free, and a very small portion of that edge which is opposite to the uncemented one.

Method No. 2.—The cover-glass is placed on a 3 in. by 1 in. slide in such a position that one of its edges exactly coincides with that of the slide. It is then firmly pressed and vaseline or cement is used, as mentioned in Method No. 1.

Method of Use.—A drop of blood is touched with the free edge of the paired cover glass or slide, whereupon the blood enters between the glasses in an exceedingly thin film, the corpuscles being spread out with beautiful uniformity, and having suffered a minimum amount of change from exposure to air and none at all from handling or pressure. When the blood film has entered, the free edge may be completely closed and the examination made. Fresh blood keeps well under these circumstances The advantages of these methods will be obvious. A number of slides can be made up and stored in a suitable air-tight bottle, and are always ready for use. No special skill is required for the making of a first-class blood-film.

Comments.—We have tested this process practically, and found that it was necessary to put the smallest possible suggestion of cement between the covers before edging them outside, otherwise the cement had a tendency to run in. When the blood enters beneath the cover, so attenuated is the film that the manipulator is apt to imagine that nothing is there, but, on examination under a microscope, a beautiful single layer of corpuscles is seen, spread out ready for examination.

DISSECTING WITH AN ERECTOR.—The ordinary compound microscope is not used as largely as it should be for dissecting purposes, one of the special instruments designed for the work being usually considered essential. As a matter of fact, any monocular microscope having a draw-tube will serve well if an erector be used. Nearly all the modern stands are fitted with a thread of the universal size at the lower end of the draw-tube, and into this the erector should be screwed. The objective that will be found most useful in conjunction is 1½in. or 2in., and a considerable variety of magnification can be secured by varying the extension of the draw-tube, the object, of course, being seen the right way up, and the tools, knives, &c., moving in natural directions. The reason why the erector has not been recognised as so useful an adjunct as it might have been, is probably because unsuitable objectives have been used with it, but the amateur preparer will be surprised at the great ease with which he can do his work with the arrangement above mentioned.

NEW APPARATUS.—It is proposed, instead of systematically reviewing new apparatus from time to time, to have a heading for "*New apparatus described by manufacturers*," and opticians who wish to notify the introduction of fresh accessories, instruments, &c., will briefly state the details for insertion. It is impossible to give a definite judgment on any item from an examination of a single specimen, and the public being made aware of the source of supply of such wares, will be better able to judge of their suitability for their requirements by communicating with the vendor, who would surely be pleased to give full information on the subject.

NOTES AND QUERIES.—Notes and suggestions will always be welcomed from readers, and any assistance we can give by replies to queries in these columns will be gladly rendered. All communications for this column should be addressed to M. I. CROSS, KNOWLEDGE Office, 326, High Holborn, W.C.

NOTES ON COMETS AND METEORS.

By W. F. Denning, f.r.a.s.

Brorsen's Periodical Comet.—This object is approaching the earth and increasing in apparent brightness. It ought to become visible at the end of January, and particular interest attaches to this return as the comet has not been seen since 1879. The following is extracted from an ephemeris by Berberich in *Ast. Nach.*, 3670:—

Date. 1901.	R.A. H. M.	Dec. ° ′	Distance of Comet in Millions of Miles.
January 14	20 35.0	−16 24	37
„ 18	20 7.6	− 9 37	37
„ 22	19 42.1	− 3 28	40

On January 18th the comet will be about 4° N. of χ Capricorni and moving rapidly to N.W.

Cometary Discoveries in 1900.—These were comparatively few and unimportant. Giacobini found a faint comet on January 31st, which remained visible for several months in large instruments. Its light was, however, so feeble that many observers with small telescopes were disappointed in their efforts to pick it up. On July 23rd Borrelly discovered a pretty bright comet with a tail. The object was independently swept up by Brooks a few hours later. The comet was a very interesting and fairly conspicuous one during several weeks, being visible all night in the northern sky. Parabolic elements appear to satisfy the observations in both cases. No periodical comets have been redetected during the year.

The Leonid Meteoric Shower.—The Leonids again failed to put in an appearance, and we have only to admit the fact that planetary perturbation has disturbed the stream to such a degree that the denser portion was enabled to escape encounter with the earth. After the negative results of 1898 and 1899, we were better prepared to accept failure in 1900, but the general result of observation is, nevertheless, very disappointing. The present generation had been led to expect one of the most striking and picturesque of all natural phenomena, and its almost complete absence is very regrettable on many grounds. Apart from the disappointment so widely felt, the public may be induced to entertain questionable views as regards future astronomical predictions. Perhaps it would have been much better had the computations relating to the Leonids been made several years ago, so that the public could have been fully advised as to the doubtful character of the shower's return. The work was, however, left until very late, and a good many astronomers deluded themselves and others with a mistaken confidence that the event would return quite in accordance with its usual period and traditions. It is unfortunate that, as a rule, amateurs though pretty good observers are bad computers, while professional astronomers, though not always first-class observers, are good mathematicians. The latter class cannot be expected to undertake an elaborate investigation without payment, and so the matter was delayed beyond reasonable limits. We may take comfort in the reflection that the Leonid showers are not finally lost to us. Planetary influences may affect the stream in a manner contrary to that which has operated since 1866, and bring back the rencontres which gave rise to the magnificent meteoric storms of 1799 and 1833. But for the present generation of meteor-watchers the prospect seems a very poor one, though 1901 and 1902 may bring us a few laggard members of the denser region of the stream. There will be no moonlight at the middle of November, 1901.

A large number of reports have been sent in concerning recent observations, but they are uniformly of a negative character. The Leonids were most active on the morning of November 16th, when the radiant furnished two or three meteors per hour for one observer. The radiant was at about 150°+22°. The most active of the contemporary showers was the Taurids, with a radiant at 57°+9°, which supplied some fine slow-moving meteors, with long paths and trains of yellow sparks. These Taurids are often conspicuously present during watches for the Leonids, and the stream yields an unusual proportion of brilliant fireballs.

In the presence of a notable dearth of Leonids it is satisfactory that one of these meteors, which appeared on November 13th, at 13h. 32m., was observed by Prof. A. S. Herschel at Slough, and by the writer at Bristol. It was of the second magnitude, and descended from a height of 69 miles near Wallingford to 58 miles near Swindon, traversing a real path of 24 miles with a velocity of about 48 miles per second. Several other meteors have been doubly observed, and the full comparison of the various observations appears likely to add some interesting items with regard to the minor showers of the period.

Fireballs of November 17.—Several fireballs were observed on this night, but they were not very exactly recorded. The first appeared at about 7 p.m., and there was an exceedingly brilliant one at 11h. 32m. Some large meteors were also recorded on December 13th, at 7h. 40m., 9h. 29m., 11h. 58m., and 12h. 26m. Like October 21st, the nights of November 17th and December 13th seem to have exhibited some meteoric displays of rather exceptional character.

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 a.m., and sets at 4 p.m.; on the 31st he rises at 7.45 a.m., and sets at 4.45 p.m. On the 2nd, at 9 p.m., the earth is at its least distance from the sun, the horizontal parallax being 8″95, the sun has then its maximum apparent diameter of 32′ 35″·2. Few spots are to be expected.

The Moon.—The moon will be full on the 6th at 0.14 a.m., will enter last quarter on the 12th at 8.38 p.m., will be new on the 20th at 2.36 p.m., and will enter first quarter on the 27th at 9.52 a.m. The following are among the occultations visible at Greenwich 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.
Jan. 5	1 Cancri	5.9	9.45 P.M.	129	165	10.50	258	286	14 22
„ 6	A Cancri	5.6	6.30 P.M.	108	115	7.31	277	317	15 19
„ 28	13 Tauri	5.1	8.3 P.M.	9	351	8.28	333	310	8 6
„ 28	14 Tauri	6.4	8.32 P.M.	13	20	9.28	302	270	8 7
„ 29	D.M. +20°785	6.8	6.0 P.M.	76	106	6.37	268	290	9 1
„ 31	χ¹ Orionis	4.7	2.41 A.M.	110	69	3.36	268	229	11 13

The Planets.—Mercury is not well placed for observation, being in superior conjunction with the sun on the 22nd.

Venus is still a morning star, gradually becoming less favourably placed for observation. On the 1st she rises shortly before 6 a.m., and on the 31st about 6.40 a.m. On the 15th the apparent diameter is 10″·6, and the illuminated part of the disc is 0·902.

Mars, in Leo, rises on the 1st at about 9.20 p.m., and on the 31st about 7.10 p.m. On the 15th the apparent diameter is 13″·8, the illuminated part 0·919, and the horizontal parallax 12″·9. Though the approaching opposition of February 21st is an unfavourable one as regards the distance of the planet from the earth, there is some compensation in the fact that the altitude of the planet when near the meridian is much greater in our latitude than in the oppositions, when the distance of the planet is smaller.

Eros is still favourably situated, and the following abridged ephemeris, for Berlin midnight, may be useful to those wishing to observe this interesting object:—

	Right Ascension H. M. S.	Declination ° ′ ″
February 1	3 43 52	+24 52 17
„ 6	4 2 21	22 52 11
„ 11	4 21 0	20 54 49
„ 16	4 39 43	19 0 10
„ 21	4 58 25	17 10 10
„ 26	5 17 2	+15 23 38

The apparent stellar magnitude of the planet ranges from 8.5 to 9.0 during the month.

Jupiter, Saturn, and Uranus are too near the Sun to be conveniently observed.

Neptune remains in Taurus, and may be observed throughout the night. The path is a short westerly one, nearly midway between ζ Tauri and η Geminorum.

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.

Minima of Algol occur at convenient times, on the 3rd at 11.7 p.m., the 6th at 7.56 p.m., the 26th at 9.39 p.m., and on the 29th at 6.28 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.

No. 1.
(Jeff Allen.)
1. Kt to Q5, and mates next move.

[This Problem, which has been much admired, has puzzled effectually one of our most reliable solvers.]

No. 2.
(Major Nangle.)
Key move—1. K to B4.

If 1. . . . P to K[illegible]ch, 2. K × P.
1. . . . P to K3, 2. K to K5.

CORRECT SOLUTIONS of both problems received from Alpha, H. S. Brandreth, G. A. Forde (Capt.). F. N. Worsley-Benison, H. Le Jeune, W. Nangle (Major), J. Blaikie.

Of No. 2 only from W. de P. Crousaz, J. Bernard Corp.

H. Boyes.—No. 1, If 1. R × Kt, B to B5, and there is no mate. In No. 2 you overlook after 2. B to B2, P × B.

A. Murdoch.—See answer to H. Boyes. In No. 2, after 1. B to Q4, P to K4; 2. B × BP, K to B7; 3. Q to Ksq is not mate.

J. Bernard Corp.—If 1. B to Kt6ch, Black interposes the Pawn or Knight. The King cannot go to K4 as you suggest.

F. N. Worsley-Benison.—Your solutions last month were correct, but received several days too late to acknowledge in the last number.

The Solution Tourney begins with the following Problems. The conditions were given last month, but it may be as well to repeat them The first prize is One Guinea; the second, KNOWLEDGE free for twelve months:—

CONDITIONS.

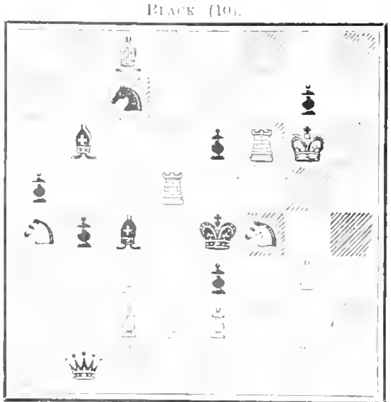
1. The Tournament will begin on January 1st, 1901, and will include all the direct mates in two and three moves printed in KNOWLEDGE during the year 1901.
2. If a Problem be incorrectly printed it will be cancelled and reprinted.
3. Key-moves only need be given. A correct key to a two-move Problem will 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.

PROBLEMS.

By W. Geary.

No. 1.

BLACK (10).

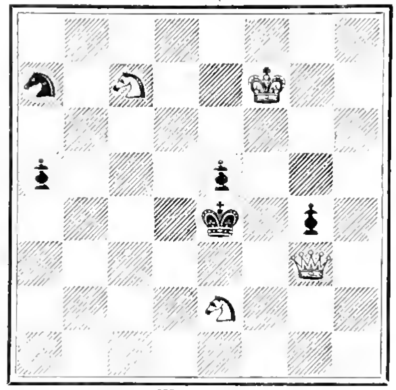


WHITE (11).

White mates in two moves.

No. 2.

BLACK (5).



WHITE (4).

White mates in three moves.

CHESS INTELLIGENCE.

An important tournament has recently been concluded at the Manhattan Chess Club, New York. With the exception of Messrs. Pillsbury and Barry, all the most prominent American players were competing. The final score was:—1, S. Lipschütz, 8; 2, J. W. Showalter, 7; 3, A. B. Hodges, 5; 4, E. Hymes, 4; 5, D. G. Baird, 3½; 6, F. J. Marshall, 2½. The relative positions are not surprising, with the exception of Mr. Marshall's failure, which is unaccountable after his recent successes. It is understood that he will compete with Messrs. Pillsbury and Showalter, at the forthcoming Monte Carlo tournament.

In the South-Eastern section of the Southern Counties' Chess Union Competition, Kent have defeated Hampshire by 7 games to 2, the other seven games being drawn. Kent are a greatly improved side, while their opponents seem to have fallen off latterly.

In the North *v.* South correspondence match of 50 players aside, Mr. Burn, at Board No. 1, has won one game from Mr. Gunston, a draw being agreed to in the other game. At Board No. 2, Mr. Locock is a Pawn ahead in both games against Mr. Schott.

A tournament is now in progress at Simpson's Divan, Messrs Lee, Mortimer, Müller, Teichmann and Van Vliet being the competitors Mr. Mortimer is also taking a prominent position in the tournament of the British Chess Club. In the City of London Tournament Mr. E. O. Jones has won his first eight games, but apparently not against the strongest players. Messrs. T. F. Lawrence, Herbert Jacobs and Dr. Smith have also made good scores.

KNOWLEDGE
AN
ILLUSTRATED MAGAZINE
OF
SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

Vol. xxiv.] LONDON: FEBRUARY 1, 1901. [No. 184.

CONTENTS.

She wrought her people lasting good

. . . .

A thousand claims to reverence closed

In her as Mother, Wife, and Queen.

FLOWERING PLANTS,

WITH ILLUSTRATIONS FROM BRITISH WILD-FLOWERS

By R. Lloyd Praeger, B.A.

I.—ROOTS AND STEMS.

We cannot take a country walk without being struck by the variety of the vegetation which carpets the surface of the ground. Lowly as are most of our native plants in comparison with those which clothe the hills and valleys of tropical countries, we find notwithstanding an infinite variety in the forms assumed by their various parts, and we may note in our islands, as well as in a Brazilian forest, the crowding, the struggling for room the way in which every nook, every coign of vantage, is occupied by growing plants. Those species which are best adapted for the conditions afforded by any particular situation and surroundings will achieve the most success in life; will grow healthy and strong, increase at the expense of their neighbours—for there is not room for all—and will eventually produce the greatest amount of seed, to scatter abroad and carry on the race. To achieve eventual success in this struggle for life, the most important point is no doubt the adequate propagation of the race; but as this can only be obtained by the success of the individual, it follows that every feature, however slight, which tends to the efficacy of the individual, is a distinct aid towards the success of the race.

The requirements of plants for the carrying on of life and growth are much the same as those which we ourselves might demand—namely, a certain amount of elbow-room, and of food and drink, light and heat. But most plants being fixed to one spot, and not capable of roaming at will, the conditions of their existence are somewhat different from those of the majority of animals. Their supply of water, and of most of the inorganic and organic substances which they need for the building-up of their bodies, must be drawn from the soil, in which they firmly fasten themselves; while for their supply of air and light they must largely depend on their own exertions, that by growth they may offer a sufficient surface to the atmosphere and to the light of day, and not allow their neighbours to unduly overshadow them.

The function of the roots is twofold. They anchor the plant firmly in its place, so that storm or rain may not overturn it or carry it away; and they absorb from the soil, by means of minute hairs, the water needed in the plant's economy, and dissolved in this water the soil furnishes the plant with various mineral salts which are needed for its growth. The roots of plants offer a considerable variety of form. Annual plants have generally a much-branched root-system, not far-spreading. Examine, for instance, the roots of the Goose-foots or Oraches that on waste ground shoot up in a single season into pyramidal masses of foliage and minute green flowers, often three feet in height, only to perish with the first frosts of winter. In plants such as these the rapid growth needs a continually increasing amount of root surface; this is acquired more easily by repeated branching than by the lengthening of a main root. Again, as the plant has not existed continuously for years on this particular spot, it has not already exhausted the soil immediately surrounding its root-stock and in a limited area it finds nutriment sufficient for a single year's growth. A third consideration is that the elaborate structure of stems and leaves does not require to be safeguarded against the storms of winter, for by the end of autumn its period of life is fulfilled; therefore a firm anchoring can be dispensed with. By way of contrast, consider the roots of a young tree. This plant has a long life before it, and the future must be carefully provided for. The roots are long and very strong and woody—much tougher often than the branches, for they are subject to greater stress. They spread widely, and hold the plant in its place with wonderful tenacity—as we realize when we try to weed out a few Ash or Sycamore seedlings that have got into our flower-beds. In the case of biennial plants, which during the first season of their existence form a rosette of leaves on a very shortened stem, and in the following year shoot up, flower, and die, the root is often much thickened, and used for the storing up during the first season of the plant-food required for the great vegetative effort of the second. Our larger native thistles furnish good examples of such foresight on the plant's part. Gardeners have taken advantage of this tendency of some species to enlarged roots to develop the character by continued selection of the most fleshy-rooted, and to their successful efforts we owe the juicy carrot, the corpulent turnip and beet, the salsify and parsnip. Biennial or perennial plants which dwell on arid plains, or in sandy ground, have particular need of long and fleshy roots, that they may store up food and water against times of drought, and in dry weather be able to tap the deeper damper layers of soil. If we examine the plants which grow on the dunes or on the sea shore, we shall find that many of them have a long fleshy tap-root which fulfils these purposes—the Sea-spurge for instance, and the lovely Horned Poppy. Note likewise the great length and succulence of the roots of the Sea-Holly. Aquatic plants live under peculiar conditions. Being wholly or in great part immersed in water, instead of air, the supply of water and dissolved salts is available to any part of the plant capable of absorbing them. Roots then become useful chiefly as anchors. In the quiet waters of ponds and ditches, even anchorage can be dispensed with, and we may find, as in the pretty Bladderworts, or the Ivy-leaved Duckweed, that roots have been altogether dispensed with; the plant forms a tangled mass of delicate stems among the other aquatic herbage, or drifts freely about on the surface under the influence of the wind. In certain exceptional cases, roots are used for purposes quite foreign to their usual functions. The Ivy, for instance, so long as it has a wall or tree-trunk to cling to, sends out from that side of its stem which is in contact with its support innumerable short roots, which fasten themselves so closely to the substratum that they will often drag with them scales of bark or pieces of plaster rather than relax their hold. These roots are generally used solely for the purpose of clinging, and the plant has in addition a well developed root-system in the soil below for the absorption of water; but they are true roots, and if on a damp wall we sever the stem, the upper part will continue to grow, fed by the clinging roots, which now take up the additional duty of supplying water.

Roots may even take on themselves the usual work of leaves, and develop chlorophyll, for the production, from the raw materials, of plant-food, in the presence of sunlight. The common Lesser Duckweed sends from the under surface of its floating fronds a bundle of little spirally twisted roots which hang down into the water, and help in no small measure to anchor the plant in its unstable substratum. These roots contain chlorophyll, and, being continually exposed to daylight, assist the green parts of the plant in carrying on that portion of the work which is in most cases performed by the leaves. But most roots, being buried in the ground, could make no use of chlorophyll, which can only fulfil its function in the presence of sunlight, and hence roots are usually not green.

In the case of the roots of most of our common leguminous plants we have, as Mr. Pearson has explained in KNOWLEDGE for October, 1900, a true symbiosis, or association of two separate organisms for their mutual benefit. In many other cases we find parasitism pure and simple, the advantages being entirely confined to one side. The curious Toothwort, for instance, has roots which, instead of absorbing nutriment from the soil, fasten themselves to the roots of other plants, penetrate their tissues, and draw therefrom a supply of plant-food ready made. In other cases the parasitism is only partial, as in the Yellow-rattle, Bartsia, and Eyebright of our pastures, which, in the keen struggle for mastery which goes on in these densely populated areas, take a somewhat unfair advantage by augmenting the food-supply which they produce by their own exertions by stealing from their neighbours by means of haustoria or suckers developed on their roots, which fasten themselves to the roots of adjoining plants. To this subject we shall have occasion to return when we speak of leaves and the part they play in the economy of the plant.

To turn now to STEMS. The stems of plants have two principal functions. They are the framework on which the leaves and flowers are spread out to catch the light and air, and they are the conduits through which the raw food materials are conveyed from the root to the leaves, and the manufactured plant-food distributed from the leaves to all parts of the organism. It is with the former use that we shall chiefly concern ourselves. The stems with which we are most familiar are those which rise into the air, generally branching as they go, and thus spreading the leaves and flowers over a considerable space, to allow all to receive their due amount of light and air; the form and structure of the stem-system depends directly on the size, number and shape of the leaves and flowers which it is designed to support. But first of all the duration of the stem must be considered. To take a few instances. In forest trees, such as the Oak or Beech, the stem lengthens year by year for a long period of time, branching at frequent intervals. To support such a huge and complicated structure under all circumstances, when loaded with leaves and fruit, or in the stress of winter gales, a stem of great strength and thickness is required. In such plants, as the stem lengthens and branches, it at the same time increases in girth year by year by means of fresh layers of woody tissue deposited underneath the constantly enlarging layer of bark; its strength to resist both compression and bending maintaining a due proportion to the weight and resistance to wind offered by the leafy boughs overhead. A great tree-trunk is the result. The trunk has many years in which to perfect its strength, and it becomes by degrees a solid column many feet in circumference of close-grained wood. The conditions are quite different in the case of an annual stem. Here the period of vegetative energy is strictly limited. The stem cannot be begun till winter is past, and must be finished in order that expanded flowers may give place to ripe fruit before winter sets in again. Hence rapidity of construction and economy of material are all-important factors in the plant's building operations. Look at the stem, often four to six feet in height, of a Wild Angelica or Cow-Parsnip, and note how beautifully it fulfils the requisite conditions. Each stem supports several large leaves, and a number of heavy umbels composed of hundreds of flowers. Their weight is considerable, and as the leaves and umbels are often raised above the level of the surrounding herbage, wind-pressure is also a serious item to be provided for. The stems of these plants are upright hollow columns, strengthened by transverse partitions at intervals. Given a certain amount of material a hollow tube is the strongest form into which it can be moulded to resist pressure and bending. The plant has adopted precisely the form in which the building materials which have during the winter been lying ready stored up in the fleshy roots can be used to the greatest advantage. These heavy umbels must be kept with their flat surfaces horizontal, else the plant would lose the striking advantages which this complicated inflorescence offers: hence the necessity of rigidity. In many other plants with tall annual stems, the form of inflorescence is such that a temporary or permanent bending of the stem will not render the flowers less conspicuous, or otherwise interfere with their proper fertilization; in these a rigid stem is less required, and by bending to the storm the plant will lessen the chance of accident. Compare then with the stout rigid hollow stem of the Angelica, with its flat umbels of flowers, the thin flexible stems of the Meadow-Sweet, Purple Loosestrife, or Meadow-Rue that grow with it, all of which bend to the breeze that sweeps across the fields. The stems of water-plants offer a different set of conditions. Just as their roots serve as anchors rather than as gatherers of food and water, so their stems act as cables rather than as conduits. The plant is buoyed up by the surrounding water, the stem has not to support its weight. It acts as a tie rather than as a strut, and flexibility and tensile strength replace rigidity and power to resist compression.

Climbing stems exhibit remarkable features which can only be briefly mentioned here. In plants like the Bryonies, Hop, Vetches, the stem is supported at many points by its convolutions, which embrace the support to which it clings, or by the leaf-tendrils which fulfil the same office. The stem is thus relieved of the task of supporting the weight of the plant, and serves chiefly as a conduit connecting with the root, and passing up water to the parts above. In these climbers the stem is thin, for strength is unnecessary, and it is flexible and tough, that it may easily follow the movements of the supporting plants. But it is the growing parts of such stems that exhibit such remarkable features. In these the rotating movement that characterises almost all the growing parts of plants attains a degree that is truly surprising; and along with this is developed an amazing sensitiveness which causes the stems or tendrils to bend towards and twine round any support with which, in their incessant movements of rotation, or circumnutation, they come in contact. Thus the climber progresses, feeling for and grasping everything that will help it in its journey to the light and air.

In a large number of plants the axis or stem is so compressed longitudinally, that, as we have hitherto understood the term, it might be said to be wanting altogether. Look at the Lesser Celandine, the Dandelion, the Daisy, and a hundred other wild-flowers. The stem is reduced to an exceedingly short root-stock, intervening between the roots on the one hand, and the point of emergence of the leaves and flowers on the other. Of stems that creep or lie prostrate on the ground, or burrow under the ground, there is a great variety. Prostrate stems, like those of water plants, have not to support the leaves and flowers, and can afford like the latter to be thin and whip-like. Such are the stems of the Ground Ivy and the Creeping Jenny, which produce leaves, flowers, and roots throughout their whole length. The Strawberry, several of the native Cinquefoils, and other wild-flowers, exhibit two kinds of stems—short upright stems, or "crowns," which give off lateral prostrate stems or "runners," often many feet in length; the latter produce at various points of their growth tufts of roots below, and leaves and flowers above, which by the withering of the intermediate portions of the stem become in their turn separate crowns, to give off new runners. Subterranean stems may conveniently be grouped similarly into those which produce leaves and flowers throughout their length, or at intervals. In the subterranean stem a further modification takes place as compared with the erect stem. Most erect stems—and prostrate stems too—are coloured green with chlorophyll, that they may assist the leaves in the manufacture of plant-food. The underground stem has no opportunity of doing this, owing to the absence of daylight, and it is usually white, or of the dull colours that most roots affect. Underground stems have likewise little need of strength, except the quiet but well-nigh irresistible strength of growth, by which the apex of the stem forces its way through the soil. Their surface, too, being buried in damp earth, is less exposed to heat and dryness, and need not guard against excessive evaporation: hence we find that underground stems are frequently brittle, with a very thin epidermis or skin. These stems are excellent places for the storage of food-materials, which is the more necessary in such plants since, the stem being below ground, the leaves and flowers have to grow up often to a considerable height above the surface to secure a due amount of light and air, and perfect the fruit; hence subterranean stems are frequently thick and fleshy—look at those of the Butter-bur, for instance. An extreme case of the storage of food in stems is found in tubers, such as the potato. In these, a great amount of food-material is stored around a few buds, which lie dormant during the winter, and use the food-store in their rapid growth during the following season. Stems may altogether supplant leaves, and undertake the manufacture of the whole of the food of the plant. The Gorse furnishes a well-known example. The seedling Gorse has little trifoliate leaves like the Genistas, to which it is related, but as the young Gorse increases in size these leaves disappear, and the green stems carry on the work of leaves, and in addition undertake the defence of the plant against grazing animals by means of the stout thorns in which the branches terminate. This principle is sometimes carried further, and the stem becomes flattened and leaf-like, the better to carry on the work of assimilation. The Butcher's Broom supplies one of the most marked instances of this to be found among British plants. That the leaf-like organs of this plant are really stem-structures is rendered evident by the fact that the minute flowers of the plant are borne on their surface. The Duckweeds likewise furnish excellent examples of leaf-like stems.

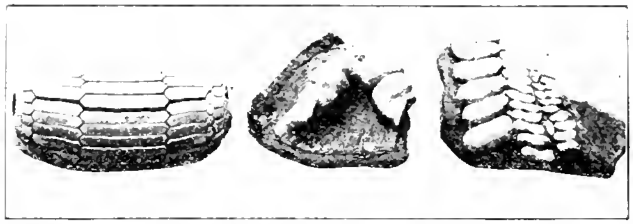
Just as the sensitive root-tip bends downward from the commencement of growth, so the stems of most plants grow towards the light. In most plants this bending towards the light, or *heliotropism*, is more powerful than their *apogeotropism*, or tendency to bend away from the direction of the force of gravity. This is well seen when plants grow in a cave or recess; their leaves and stems arrange themselves with respect to the direction of the source of light. Climbing plants are, however, but little affected by the direction of the source of light. If they were, they would frequently grow away from the structures which support them, which would be fatal to their continued climbing. Many, on the contrary, exhibit a marked *aphelíotropism*, or turning away from the source of light. The Ivy, for instance, in its growth keeps the tip of its shoot pressed against the wall or trunk to which it clings, and will follow the supporting surface into the darkest nook. And climbers like the Bryonies and Vetches will grow right up through the dark centre of a hedge, while the surrounding plants bend away from the hedge, seeking the light on either side.

LIVING MILLSTONES.

By R. Lydekker.

The mill-like action of their own upper and lower molar teeth upon one another may have been quite sufficient to suggest to our prehistoric parents the idea of opposing a pair of corrugated stones in such a manner that by mutual rotation or revolution they should be capable of reducing to powder hard substances placed between them. Indeed the idea of millstones is such a simple and natural one that it is quite probable it may have occurred to the human mind without reference to any prototype in nature; and, in any case, if such a natural prototype is to be sought, it is not necessary to go further in search of it than our own dental organs. Excellent, however, for their special purpose as are these organs (when not subject to premature decay), there are other types of tooth-structure to be met with in the animal kingdom which present a much closer approximation to millstones, and might well have foreshadowed these instruments, had they only been accessible to the primeval savage. But since these natural millstones occur only in marine fishes, some of which inhabit distant seas, while others are met with only as fossils deeply buried in the rocks, it is evident that the idea of artificial millstones is not derived from these natural prototypes. In other words, to use an expression now fashionable in natural science, the development of artificial and natural millstones is a case of parallelism.

In spite of the fact that their early ancestors were provided with a good working set of sharply pointed dental organs, birds in these degenerate days manage to get along without teeth at all. A few mammals, too, like the South American anteaters, are in the same condition; and some people have thought that in a few more generations civilised man himself will be reduced to the same toothless state. The great majority of mammals, however, possess a more or less efficient set of teeth, varying in shape, size, and number according to the need of each particular species or group. But there is one feature common to these organs in mammals of all descriptions; and this is that they are strictly confined to the margins of the jaws, never extending either on to the palate, or to the space enclosed between the two branches of the lower jaw. In many reptiles, such as crocodiles and a large number of lizards, the same law of dental arrangement obtains. In some lizards, and still more markedly in certain extinct members of the reptile class, we find, however, a number of teeth developed on the palate, having flattened crowns, and thus tending to make the mouth act the part of one large millstone. But we must descend a stage further in the scale of animated nature before we come to structures which are strictly comparable with artificial millstones and crushing cylinders. And it is in the class of fishes that we meet with these organs



1. 2. 3.

Fig. 1.—A Dental Plate of a Beaked Eagle-Ray (*Rhinoptera*).

Fig. 2.—Imperfect Dental Plates of a Palæozoic Shark (*Cochliodus*).

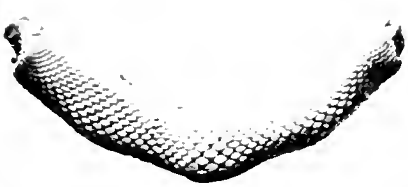
Fig. 3.—Some of the Lower Crushing Teeth of an Enamel-scaled Fish (*Cœlodus*).

in the full perfection of this type of development. Not that they occur by any means in all the groups of that class; the fact being that at the present day living millstones are going out of fashion, the great preponderance of modern fishes having their dental armature mainly restricted to the margin of the jaws, with or without a minor development of crushing teeth on the palate or the bones of the gullet. With the exception of a comparatively limited number of cases, showing a different type of development, to which it is not my present intention to allude, these dental millstones are confined at the present day to those hideous marine fishes commonly known as skates and rays, and to the singular Port Jackson shark and a few allied species inhabiting the Pacific and Malayan seas. On the other hand, the seas of the Cretaceous, Jurassic, and antecedent epochs absolutely swarmed with numerous kinds of sharks, more or less nearly related to the Port Jackson species, whose mouths were filled with pavements of teeth showing marvellous variety of structure and beauty of ornamentation. The skates and rays, too, displayed types of dental millstones quite unlike any of those of the present day. And in addition to these, there were hosts of enamel-scaled fishes whose mouths were likewise crammed with beautiful crushing teeth, albeit of a totally different type of structure to that obtaining in either the sharks or the rays. Although well nigh extinct, these enamel-scaled fishes are still represented by the bony pike of the rivers of North America, and the bichir (remarkable for its fringed fins and the row of finlets down its back) of tropical Africa. But it is noteworthy that in neither of these survivors of an ancient group do we find the mouth furnished with an apparatus of millstones; while, as already said, among the host of sharks that infest the warmer seas of the globe it is only in the Port Jackson species and its three kindred that we find similar structures retained; all the other members of the group having developed cuspidate teeth adapted for seizing and tearing soft-fleshed prey, instead of for grinding up mail-clad food.

Clearly, then, there has been some general cause at work which has rendered crushing teeth, so to speak, unfashionable among the fishes of the present day and the immediately antecedent epochs. And in this connection it is important to notice that there has been an even more strongly marked tendency to the extinction of the enamel-scaled fishes, and their replacement by the ordinary soft-scaled fishes so abundant in the present seas. As the majority of these old mail-clad fishes, as well as a large proportion of the ancient sharks were provided with crushing teeth, it is a fair inference that their food consisted largely of shell-fish and crustaceans with a certain proportion of their own mail-clad relatives. When, however, the swift-swimming soft-scaled fishes came to the fore, they would naturally offer a more tempting and nourishing diet to such sharks and other predaceous members of their own class as were swift enough in their movements to make them their prey. And consequently the old millstone-jawed sharks would tend to more or less completely disappear. On the other hand, the skates and rays, which are for the most part slow-moving creatures, flapping sluggishly along on the sea-bottom by means of their fan-like fins, would be quite unable to capture the modern type of swift-swimming fish. And they have thus had to content themselves with the old-fashioned diet of shell-fish and crabs, in consequence of which a large proportion of them have retained the dental mill-stones which have been so steadily going out of fashion among their more advanced relatives. Not that these rays and skates have by any means been content with the kind of molar machinery that did duty for their forefathers, since some of them, together with their Tertiary ancestors, have developed what appears to be an absolutely perfect type of living mill, far superior to that which served the purpose of their predecessors. And it must always be remembered that these beautiful living mill-stones and cylinders (which are some of the most exquisite bony structures to be met with in the whole animal kingdom) excel their artificial substitutes in that they never wear out; being renewed either by the development of new teeth on the inner or hinder aspect of the cylinder, or by vertical successors replacing the individual teeth from below or above.

And now that the dental mill-stones of the rays have been mentioned, it will afford a convenient starting-point for a brief survey of some of the most remarkable types of structure presented by these curious organs.

The teeth of rays always form a pavement-like



4.

5.

Fig. 4.—Upper Teeth of Beaked Ray (*Rhinobatis*).

Fig. 5.—Part of the Palate of *Lepidotus*, an Enamel-scaled Fish from the Wealden.

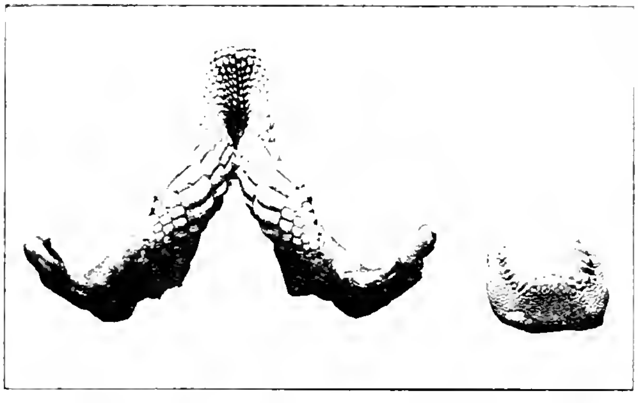
structure, of which the component elements are arranged in straight longitudinal rows, although (Fig. 4) they may likewise show a quincunxial mode of arrangement. The individual teeth are not replaced by vertical successors; but, being in the form of a half-cylinder, as those in front become worn down, the whole series is pushed forwards, and new teeth are developed on the hinder margin of the cylinder. The supreme development of a dental structure adapted for crushing in the group occurs in the family of the eagle-rays (*Myliobatidæ*), in which the millstone (Fig. 1) of each jaw forms a perfect semi-cylinder or plate, made up of flat-crowned prismatic teeth united at their edges, often so as to constitute a mosaic-like pavement. No piece of modern machinery can be better adapted for crushing hard substances than are these beautiful ivory cylinders and plates, the crushing power of which, when worked by the strong jaws, must be enormous, and sufficient to grind the strongest shell that can be introduced between them to powder. Although in all cases pavement-like, the millstone differs considerably in the different species in its structure. As an illustration of the group we may take one of the millstones of the beaked eagle-rays (*Rhinoptera*), shown in Fig. 1. Here the millstone is in the form of a semi-cylinder, consisting of five or more rows of teeth, a very usual number being seven. Generally (as in the figure) the teeth of the middle row are the widest; those of the rows on either side being considerably narrower, while the two or three marginal rows on each side may be compared to the tessaræ in a mosaic pavement. A further development of the same type is exemplified by the typical eagle-rays (*Myliobatis*), in which the middle row of teeth in the millstone becomes still wider, while the three lateral rows on each side are reduced to the condition of hexagonal tessaræ. Moreover, whereas in the species of *Rhinobatis* both mill-stones are in the form of half-cylinders, in *Myliobatis* the upper one alone retains this form, the lower being a flattened plate. The culmination of this type of structure is displayed in the rays belonging to the allied genus *Aetobatis*, in which both upper and lower mill-stones are flat and composed only of the middle row of teeth, which are of great width; the lateral rows having completely disappeared. The existing representative of this genus is not very large (for a ray), seldom if ever measuring more than about five feet across; but some of its extinct predecessors must have been monstrous fish, as the teeth measure five or six inches in diameter.

Quite a different type of dental armature is presented by the millstones of the beaked rays (*Rhinobatidæ*), of which a specimen from the upper jaw of a species belonging to the genus *Rhynchobatis* is shown in Fig. 4. Here the teeth take the form of closely packed diamond-shaped knobs, arranged in an alternating manner, so that although they present longitudinal rows, yet they also show oblique series, so as to give rise to a quincunxial pattern. Then, again, the entire millstone in each jaw is thrown into a series of undulations, so that the upper one, as in the figure, exhibits a large median boss, flanked by a pair of smaller undulations, which are received into corresponding depressions in the lower millstone. It is difficult to conceive a machine better adapted for crushing than is presented by the jaws of the beaked rays.

Of a much less powerful type are the mill-stones of the ordinary rays or skates (*Raiidæ*) of our own coasts, and among these the common thornback (*Raia clavata*) presents a very remarkable condition, since the individual teeth take the form of oblate knobs in the female, whereas in the male the centre of each of these knobs acquires a sharp recurved point. Since everything in nature has a meaning, it would seem a fair inference that there must be some important difference between the food of the male and female thornback, but I have not come across any observations bearing upon the subject.

Among the fossils to be obtained occasionally from the workmen in large chalk-pits are teeth of the type shown in Fig. 7; the specimen depicted having been purchased by myself in a pit near the road between Chatham and Maidstone. As many others were offered at the same time, it doubtless formed part of a more or less complete millstone, which, as is too often the case, was broken up by the workmen. These teeth form convex quadrangular bosses, the marginal portion of which consists of a broad granular area, while the centre is occupied by a variable number of bold ridges, or folds, between which are often irregular knobs. It is from these ridges that the fish take the name of *Ptychodus*. For a long time it was uncertain how these teeth were arranged, but careful comparison of a number of more or less incomplete series *in situ* has at length solved the problem. In the lower jaw the complete millstone was formed by a median row of large teeth similar to the one figured, on each side of which were six or seven other rows composed of teeth gradually decreasing in size from the centre to the margin. In the upper jaw, on the other hand, there was a central row of small teeth, flanked on each side by a row of large ones, externally to which came a series of rows gradually diminishing in size. From this mode of arrangement it is inferred that *Ptychodus* was a ray; and the whole dental structure is as remarkable for its perfection as a crushing machine as it is for its intrinsic beauty.

Even more elegant from an æsthetic point of view are the "millstones" of the Port Jackson shark (*Cestracion*) and its allies; the upper jaw of the Australian species being shown in Fig. 6. In place of forming a continuous plate across the palate after the fashion of the eagle-rays, the individual teeth in this group are arranged in oblique bands round the edges and inner sides of the jaws,* showing in the hinder region a melon-shaped swelling of remarkable gracefulness, which would form an attractive ornament for the capital of a pillar. In this melon-like portion



6 7.

Fig. 6.—Upper Dentition of the Port Jackson Shark (*Cestracion*).
Fig. 7.—A Tooth of the Ridge-toothed Ray (*Ptychodus*).

of the millstone the individual teeth form bluntly convex oblongs; those of one row being markedly larger than all the rest, while the rows in front of and behind this do not correspond with one another in size

* Strictly speaking the tooth-bearing cartilages of sharks are not true jaws.

Examined with a lens, each of these blunt teeth is seen to have a minutely pitted structure, while its median longitudinal line is marked by a narrow smooth streak. New teeth are being continuously produced on the margin of the series on the inner side of the jaw, and as the outer ones become worn away, the whole series is pushed over towards the edge of the jaw. Proceeding from the larger rows of teeth towards the front of the jaw, it will be seen that as the individual teeth become gradually shorter their smooth median line gains prominence, till it finally develops into the sharply pointed cusp surmounting each of the front teeth.

As already said, the Port Jackson shark and a few other nearly related species (all of which, by the way, feed on shell-fish and crustaceans) are the only sharks with millstones met with in our present seas. And it is fortunate that these have lived on, as otherwise we should never have gained a true idea of the dental armature of their extinct relatives which abounded in the seas of the Jurassic epoch. Visitors to Whitby must be familiar with certain black oblong fossils of about an inch and a half in length known to the quarrymen as "fossil leaches." These are the hinder teeth of an extinct shark (*Asteracanthus*) nearly allied to the Port Jackson species, but of much larger size; and although they are more rugose than pitted, they show the same smooth line on the summit. A beautiful specimen from Caen, in the British Museum, shows that the arrangement of these hinder teeth was almost exactly the same as in *Cestracion*, which may thus be regarded as a survivor from a long past epoch of the earth's history.

But there were other "millstone-mouthed" sharks at a still earlier period which appear to have been allied to *Cestracion*, although the degree of relationship is uncertain. In these Palæozoic sharks, as exemplified by *Cochliodus*, of which the imperfect millstones are shown in Fig. 2, the series of hinder teeth seem to have had an arrangement very similar to that obtaining in *Cestracion*, but the individual teeth of several series were more or less completely fused into a single solid plate, the ridges on which mark the original lines of division between the component series. These sharks exhibit, therefore, one among many instances where the earlier forms of a group are in some respects more specialised than their descendants.

So much space has been taken up by the rays and sharks that only a few lines remain for the millstones of the enamel-scaled fishes. In none of these do the teeth, which are developed on most of the bones of both the upper and lower jaws, ever form continuous plates; and they are generally either spherical (Fig. 5) or kidney-bean-shaped (Fig. 3), and arranged in more or less distinct longitudinal rows. Unlike those of the sharks and rays, these teeth, as in the familiar *Lepidotus* of the Wealden (Fig. 5), are replaced by vertical successors; and their mode of development is so peculiar that in some cases the new tooth is placed wrong way up beneath the one it is destined to replace. In other instances, as in *Cœlodus* (Fig. 3), from the Folkestone Gault, successional teeth have not been observed, and the mode of renewal is consequently still unknown. Although within the limits of a single article in Knowledge it is impossible to do more than give the crudest sketch of a vast subject, yet what has been written may be sufficient to attract my readers' interest to an extremely fascinating branch of zoological study.

MRS. QUICKLY'S "TABLE OF GREEN FIELDS."

By the Rev. D. R. Fotheringham, M.A. (Cantab.)

One of the pleasures of life in a remote Highland village is to take down my old volumes of Knowledge and turn over the sparkling pages of Mr. Proctor's conductorship. While occupied thus a short time ago, my attention was struck by an article bearing the pseudonym of Malvolio, and dealing with the text of Shakspere. An inexhaustible subject truly! For whether it be true or not that the fluent bard scarce effaced a line, yet the critics and commentators of three centuries have done their worst, effacing, blotting, blurring, adding, correcting, altering, spoiling, until in many cases the original text seems to be hopelessly lost beneath the load of conjectural emendation. True lovers of English literature cannot but protest against this treatment of the poet's work, and there is a growing desire among them to return to the original folio editions of the plays, rather than yield further acceptance to the corruptions introduced by successive editors.

That the folio text of Shakspere is sometimes incorrect and requires emendation may be readily granted; but it is unhappily true that many alterations have been made in pure wantonness of spirit, and have no justification whatever. One may recollect, for instance, how Hamlet is addressed by the courtier Osric as "your friendship." Osric is a Euphuist, and delights in the use of strange and affected language. But when the clumsy pen of an undiscerning editor has altered "friendship" to "lordship," poor Osric's character is gone for ever, and he is nothing more than a commonplace young man, who might almost be mistaken for sensible.

An instance of still worse emendation might be cited from Julius Cæsar. It will be remembered that before his assassination the conspirators approach him with a petition, and each of them kneels in order to present it, Cæsar protesting the while and bidding them rise. Cinna falling at his feet is repulsed with "Hence! wilt thou lift up Olympus?" Immediately afterwards Decius Brutus kneels, and is more kindly met with, "Do not, Brutus, bootless kneel." All this is simple enough. It happens, however, that there is another Brutus on the stage, the famous Marcus Brutus, and there is no direction to indicate whether he is kneeling or not, though the previous language makes it probable that he is. Editors, however, have generally supposed him to be still standing, and taking Cæsar's words as addressed to him (very absurdly, one cannot help thinking), they have ventured to alter "do" into "doth," and to add a mark of interrogation at the end. It will surely be agreed that in this case there is no need for any alteration whatever, and that the alteration actually made is vastly inferior to the original reading of the folio.

These two instances have been deliberately chosen from many hundreds, as representing different classes of passages to which conjecture has been applied. In the one case Osric's own language, like Mrs. Malaprop's, tempts us to correct him; though only a dull wit should yield to such temptation. But the other is an example of editorial licentiousness that cannot be too strongly condemned.

But the most famous of all critical conjectures applied to the text of Shakspere is Theobald's correction of the hostess' language (she is known to us as Mrs. Quickly, though now married to Pistol) in describing the death of Sir John Falstaff. The folio reads:

> After I saw him fumble with the sheets, and play with flowers, and smile upon his fingers' ends, I knew there was but one way; for his nose was as sharp as a pen, and a table of green fields. "How now, Sir John!" quoth I.—King Henry the Fifth, II. 3.

The reading is sufficiently surprising as it stands. That Falstaff's nose might look as pointed as a pen is not impossible. Indeed, such a sharpening of the nose was then looked for as a sign of approaching death. But the table of green fields is too outrageous a comparison, even for Hostess Quickly. Here if ever is a case where conjecture seems legitimate, or even necessary, and one editor at least has risen to the occasion with a poetical instinct that is far from common among critics generally.

Let us deal with the bad alterations first. In Staunton's opinion they need only be mentioned to be laughed at. But at all events Mrs. Quickly (or Pistol) is a comic character, and laughter will not be out of place. For "and a table of green fields," then we are invited respectively to read "in a table of green fields," "on a table of green frieze," and "or as stubble on shorn fields." Only the last of these makes any improvement in the simile, but the conjecture is too bold to have a place in legitimate criticism. Even bolder, however, was Pope's treatment of the passage, and it is right to give it in his own words: "A table was here directed to be brought in, and this direction crept into the text from the margin. Greenfield was the name of the property man in that time who furnished implements for the actors. A table of Greenfield's." Pope's suggestion must stand or fall by its own merits, for comment is superfluous.

Better, however, is forthcoming. These suggestions may be left to speak for themselves and provide merriment for Staunton's followers, while we pass on to the conjecture now generally received. Some unknown gentleman in the early part of the seventeenth century had altered "table" to "talked," and left a manuscript note in the margin of his Shakspere. This note caught Theobald's eye, and with admirable instinct he corrected "talked" to "babbled," thus reading "and a' babbled of green fields." We thus get a complete and beautiful picture of Sir John's last moments, and may well feel pity for the poor knight, fumbling with the sheets, playing with flowers, smiling on his finger's end, while his thoughts turned from that sordid Eastcheap inn to the far off country "and a' babbled of green fields."

The trouble is that the emendation is a great deal too poetical. It is not in keeping with Mistress Quickly's character, however much that character may have been etherealized by Pistol's companionship. We have not to deal with Sir John's "finer end" so much as with her recollection and description of it; and even if the knight's thoughts had been sufficiently purified by the approach of death to take delight in rustic scenes, she was hardly the woman to notice it. She was kindly enough in her way, and could "lay more clothes on his feet" when he wanted them, or call in his friends to witness his burning "quotidian tertian," or essay to comfort him (knowing him to be at the point of death) by bidding him "not think of God; for there was no need to trouble himself with any such thoughts yet." Her religious character is further manifested by the reflection that Sir John is now in Arthur's bosom; and that the incarnation of devils would give them an objectionable colour. She remembers too that he was rheumatic (accent on the first syllable), and therefore unaccountable for his words, and that he cried out of sack, and talked of the whore of Babylon. But she r entirely lacking in finer appreciations. Indeed it is very questionable whether there was anything very fine to appreciate. If Falstaff cried out of sack, and of women, of devils, the whore of Babylon, and the flea on Bardolph's nose that reminded him of a black soul in hell-fire, his conscience may have been troubling him sorely enough, but it may be doubted whether his thoughts ever ran on rustic scenes of Nature in her purity and grace. Certainly if they did, the hostess would dismiss them as "rheumatic" again, and they would never be retained in her dull and prosaic mind.

It is to be feared then that Theobald's conjecture, beautiful as it is, must be abandoned, and as the same fate has befallen every other conjecture, we are forced back upon the text of the folios. Is it possible to make sense of this? The question is well worth answering: for if we can make sense of the original, the need for emendation disappears at once, and every conjecture, good or bad, must fall to the ground.

"His nose was as sharp as a pen and a table of green fields" has been supposed to mean that his nose had a pointed look and was covered with spots. But this seems to be forcing the language. Besides green is hardly the colour one would expect on Falstaff's nose, whether in spots or otherwise. A much better plan seems to be to take the clause, "For his nose was as sharp as a pen" as parenthetical. The sentence then reads, "I knew there was but one way (for his nose was as sharp as a pen) and a table of green fields." Sir John had only one more road to go, and that was the road to the churchyard, ending amid the little green mounds that are scattered over God's acre.

This suggestion is offered with a good deal of diffidence; yet haply it may do something to clear up an admittedly difficult reading.

NOTES.

Astronomical.—Professors Liveing and Dewar have obtained evidence of the possible existence in our atmosphere of the chief gases which are luminous in the solar corona and in nebulæ. After freezing out the more condensable gases, such as argon, nitrogen, and oxygen, by exposing the mixture of gases to the temperature of liquid hydrogen, the spectrum of the residue was found to contain lines of hydrogen, helium, and neon, together with certain unknown lines. Among the latter were several weak lines which seem to correspond with the principal lines in Sir Norman Lockyer's list of coronal radiations, and in one experiment a line was obtained which falls very near to the chief nebular line in the green. The experiments also conclusively demonstrate the existence of free hydrogen in our atmosphere.

The approaching opposition of Mars has already brought a crop of sensational newspaper paragraphs. Early in December, Mr. Douglass, of the Lowell Observatory, announced the observation of a projection on the northern edge of the Icarium Mare, which remained visible for seventy minutes. In newspaper language: "A series of bright lights suddenly appeared in a straight line extending for several hundred kilometres." In its exaggerated form the observation of course suggests a message from the Martians, but the actual observation is by no means so conclusive.—A. F.

Botanical.—The Grasswrack *(Zostera marina)*, a common plant of sandy or muddy places near the sea in Britain and other temperate countries, has been discovered by Captain Deasy in the Kuen Lun Mountains, Tibet, at an elevation of 16,500 feet. Specimens collected in this extraordinary situation were exhibited by Dr. A. B. Rendle at a recent meeting of the Linnean Society. They were not growing when discovered, but were preserved in what is believed to have been the bed of a salt lake. Though dry and brittle, a microscopic examination revealed an internal structure as perfect as that of living specimens. This species has never previously been found in an inland lake, though the Dwarf Grasswrack *(Z. nana)* is known from the Caspian Sea. In the *Journal of Botany* for January we are informed that a paper on Captain Deasy's interesting discovery will shortly appear in that publication.

Primula obconica, since its introduction into our gardens twenty years ago, has been the subject of considerable attention, both on account of its wonderfully floriferous character and poisonous properties. Instances of skin irritation, sometimes of a very violent nature, caused by handling the plant, have been recorded from time to time in the *Garden and Forest*, the *Gardeners' Chronicle*, and other journals. A valuable contribution to the literature concerning this *Primula* has been supplied by Herr A. Nestler in the *Berichte der deutschen botanischen Gesellschaft* for 1900. The author gives the results of a series of experiments which he conducted with the view of ascertaining what part of the plant produces the irritation. He found that water, which collected on the margins of the leaves when the plant was placed in a moist room, or juice, which he expressed from the leaves and flower stalks, had no effect. A young umbel applied to the wrist by an elastic band for two hours proved almost harmless; but a piece from the base of a leaf-stalk applied in the same way for two hours produced acute irritation with blisters and swelling of the arm. Herr Nestler shows that it is the yellowish-green matter in the glandular hairs which possesses the poisonous properties.—S. A. S.

Entomological.—The "driver" ants of America and Africa are well known to readers of the works of Belt and other travellers in the tropics. For a long time the "worker" ants included under this designation could not be referred to the same species as any known forms of developed females or males. Dr. Sharp, in the "Cambridge Natural History" (Vol. VI., pp. 174f.), gave a summary of recent researches which have established the remarkable fact that the developed forms of several African species of "driver" ants had long been known to naturalists under distinct generic titles, so marked is the divergence between the forms in these insects. Quite lately Prof. W. M. Wheeler describes (*American Naturalist*, XXXIV., 1900, pp. 563-574) the hitherto unknown female of *Eciton*, the American genus of driver ants (the male had already been described under a different generic name). These females are, like the workers, wingless, but they differ most remarkably in size and form, being four times as large, and having only one "nodal" segment in the hind body. The workers have two, and this character of the "nodal" segments is a leading one in discriminating the subfamilies of ants; here, however, it varies in the same sex of the same species." The female *E.* [illegible] has a swollen head-body like that of a young [illegible] queen termite and lays a vast number of eggs. She is often covered with a multitude of parasitic mites. Prof. Wheeler gives some interesting details of rove-beetles found in the nests of *E.* [illegible]. His observations confirm the results obtained by Wasmann who noticed that the "guest" beetles in the nests of these ants resemble their hosts closely in form and sculpture, but often differ in colour. The ants being blind, the "mimicry" of the beetles is thought to deceive their sense of touch, it being needless to deceive a non-existent colour sense.—G. H. C.

ZOOLOGICAL.—At a recent meeting of the Zoological Society the secretary exhibited two strips of the skin of a zebra, sent by Sir Harry Johnston, from the Semliki River, near the border of the Uganda Protectorate. These appear to indicate an entirely unknown representative of the group.

Judging from the report of Mr. W. Garstang, published in the November issue of the *Journal* of the Marine Biological Association of the United Kingdom, the swarms of octopus which have recently appeared on both sides of the British Channel are inflicting untold harm on the crab, lobster, and oyster fisheries. The increase in the numbers of this comparatively scarce cephalopod was first noticed in the spring of 1899, since which date the creatures have appeared in such hosts as to justify the application of the term "plague" to the visitation. The quantity of shell-fish destroyed by these voracious cephalopods is almost incredible. Fortunately the octopus itself is not difficult to capture, and a fisherman can easily account for more than half a hundred per week in the course of his work. On the French coast they are taken and sold for food; and the quantities caught on the two sides of the Channel ought to have some appreciable effect on the numbers of the pest.

The third series of reports to the Malaria Committee of the Royal Society has just been issued and contains the results of observations made by Drs. Stephens and Christophers on the west coast of Africa, and by Dr. Daniels in East Africa. The two former writers urge that it cannot be too clearly realised by Europeans living in the large towns of West Africa that they are dwelling amidst thousands of cases of malaria none the less dangerous from the fact that the native children suffering from the disease do not exhibit the usual signs of fever. "Malaria is essentially a contagious disease, the contagion being conveyed by the mosquito; the laity must appreciate this fact and refuse to dwell in the midst of contagion; they must recognise that malarial fever is a contagious disease contracted (through the medium of the mosquito) from the native child. Malarial fever, we are convinced, can be avoided most readily by avoiding the cause of contagion, and living as far removed as possible from native huts." The adult native possesses an active immunity against malaria, and though living under the same conditions as the children, constantly subject to the bites of infected *Anopheles*, yet examination of his blood shows that parasites are always absent.

The latest issue of the *Geographical Journal* contains a most interesting account of the results of Mr. Moore's recent expedition to Lake Tanganyika and the regions to the northward. Mr. Moore brings forward additional arguments in favour of the marine origin of the fauna of this lake (which includes shells of a marine type and a jelly-fish); and from the absence of a similar assemblage of animals in the more northern lakes, he is led to conclude that Tanganyika [illegible] in the [illegible] was the Congo basin and [illegible] N[illegible] valley.

In the November [illegible] *[illegible]* [illegible] the Millport Marine B[illegible], Dr. Gemmill endeavours to ascertain whe[illegible] [illegible] living in the higher tidal zones support [illegible] inferior nutrition tends to the development [illegible] of females. In these molluscs the sexes are [illegible] until some time after the free-swimming [illegible] is abandoned; and since the individuals left dry only at very low tide are, owing to longer opportunities for feeding, generally superior in size to those living in a higher zone, they ought to confirm the theory, if it be true in all classes of animals. No preponderance of males was, however, observable in the low-tide individuals.

CONSTELLATION STUDIES.

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

No. II.—THE REGION OF LEO.

THE February nights bring to the meridian the most famous of all the constellations of the Zodiac; the constellation, that is to say, of the Lion. Its primacy is beyond question due to the fact that the place of the sun at the summer solstice was in this constellation at the time when they were first devised, and no doubt its brightest star derived its name, Regulus, or "little king," as being the chief star of the paramount sign. Both names are traditional in many different countries; the constellation is the Latin Leo, the Hellenic Λέων, the Persian Shir, the Hebrew Aryeh, and the Babylonian Aru, all alike meaning "Lion"; whilst our present name for the star is the variant, proposed by Copernicus, for the older Latin Rex. Ptolemy calls it Βασιλίσκος, the Arabs give it Malikiyy, the "kingly" star, and the cuneiform inscriptions of the Euphratean valley refer to it as the "star of the king," whilst in ancient Persia it was the chief of the four "royal stars." It is its place, however, and not its brilliance, which has gained for Regulus this distinction, for almost all the first magnitude stars are its superiors in brightness.

The constellation of the Lion is very easily found when the Great Bear is known.

"North her hind feet 'ns rushing on his prey
The lordly Lion greets the lord of day."

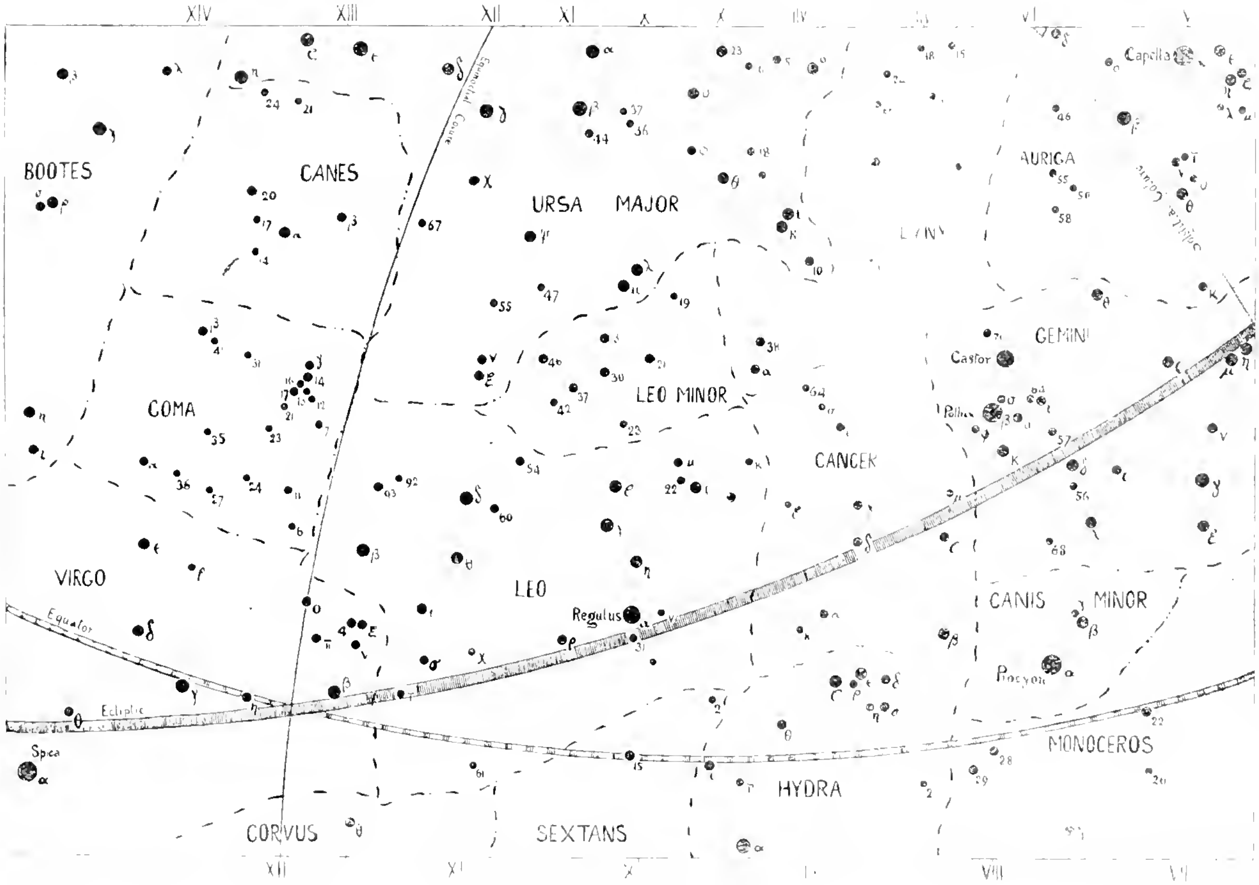
The Great Bear at this season at midnight is at its greatest elevation, and below it towards the south, we find the Lion. The stars in it are formed into two principal groups. The Sickle, six bright stars marking the animal's head and breast, whilst a Rectangle indicates its hindquarters. A line from Alpha in the Great Bear through the third foot, that marked by Lambda and Mu, and prolonged beyond the foot to an equal distance, brings us to the centre of the blade of the Sickle, whilst another line from Gamma through the fourth foot leads to the Rectangle.

The stars of the Sickle, beginning with the most westerly, run in the following order, Epsilon, Mu, Zeta, Gamma, Eta, Alpha. In the [illegible] of the trapezium made by the first four of these [illegible] of the radiant of the celebrated [illegible] shower of meteors, the showers which [illegible] splendid displays in 1833 and 1866 [illegible] in truth [illegible] our knowledge of [illegible] since they first drew [illegible] the subject of [illegible] and afforded [illegible] of the [illegible] which they present.

The fourth star Gamma [illegible] but little inferior to Regulus in brightness [illegible] interesting and beautiful double star. It bears the Arabic name Algieba, meaning "Forehead," though it is actually situated on the Lion's breast. It forms a fine contrast in colour to Regulus, being distinctly deep yellow, whilst the latter is white. Gamma, Zeta and Epsilon are all interesting as opera-glass objects from the companions which a slight optical assistance brings into view.

Leaving the Sickle, we come to the Rectangle, the four stars marking which are of very different magnitudes. Delta and Theta mark the western side; 93 and Beta the eastern; of these Beta is much the brightest, Delta following next. Beta is Denebola,—one of the many Denebs, that is "Tail," which we find in the sky,—and from its companion stars, forms an interesting opera-glass field. Cancer is the smallest and least conspicuous of all the constellations of the ancient names, but there are some slight variations in the figure ascribed to the entire constellation, the Egyptians tracing here a scarabaeus, and some of the mediæval astronomers representing it by a lobster or crayfish.

Passing on further to the west, a pair of bright stars are seen as far below the forefoot of the Great Bear as Alpha is above it. These are Castor and Pollux, the two chief stars of the constellation Gemini, the "Twins." This constellation is, according to Brown, a stellar representation of the great Twin Brethren of the sky, the sun and the moon, who join in building a mysterious city and who are hostile to each other although they work together. In classical legend they are the children of Zeus and Leda, the Dioskouroi, and by no means have the fraticidal relation which this interpretation would suggest. The idea of strife between sun and moon



Star Map No. 2: The Region of Leo.

Zodiac. Its most significant feature is found in the centre of the group; a pair of stars between the fourth and fifth magnitude, Gamma and Delta, north and south respectively of a misty looking object. These are the twin "Asses," standing right and left of their "Manger," Praesepe.

> "Like a little mist
> Far north in Cancer's territory it floats,
> Its confines are two faintly glimmering stars;
> These are two Asses that a Manger parts."

Many a young beginner has fancied that in Praesepe he has discovered a new naked eye comet, but the least optical aid shows it to be a cluster of small stars, and directly Galileo turned his telescope upon it, he detected its nature, counting some thirty stars within its borders. The Asses and the Manger appear to be is natural enough, and no doubt many stories like that of Romulus and Remus took their form from such a nature myth. But the idea of strife is not the leading one in most of the legends relating to the stars Castor and Pollux, who are indeed shown as man and woman on many zodiacs, and I think that this fact renders it questionable if it is safe to press far the considerable doubt on the root idea of Mr. Brown's theory that the ancients, so to speak, solarized the stars, designing the constellations to perpetuate the stories in which they had dramatized their conceptions of solar and lunar relations.

The limits of the constellation are easy to trace out. Four fairly bright stars, nearly in a straight line, mark the feet of the Twins, whilst Castor and Pollux mark the Heavens. They are standing in fact upon the Milky Way. The four feet stars are Mu, Nu, Gamma, and Xi. Close by Mu is Eta, another star in the foot of Castor, and in the neighbourhood of these two stars is a splendid cluster, 35 Messier, which is just visible to the naked eye, but which well repays examination with the opera-glass. Castor is one of the most celebrated of double stars, though of course altogether beyond the grasp of an opera-glass as the components are not 6" apart, but the constellation as a whole is a fine one for examination with the opera-glass, especially in the region of the Milky Way. The contrast in colour between the two principal stars, Castor and Pollux, is noticeable enough even with the naked eye, but becomes very striking when the glass is turned upon them. Gemini forms the home of several important meteor-radiants, especially that of December 10 to 12.

Between Leo and Ursa Major is a modern constellation, called Leo Minor, framed by Hevelius out of the unformed stars which he found in this region. Its components none of them exceed the fourth rank, and it is chiefly noticeable to the naked-eye astronomer as the home of a meteor radiant of the second rank.

The Lynx, lying between Ursa Major and Cancer, is

[illegible] 1904 February.

an even fainter constellation than Leo Minor. Its two principal stars, Alpha and 38, make a visual pair, very similar to the three that have already been noted as marking the plantigrade feet of Ursa Major, and as Prof. Young has suggested they might well have been taken to have made up the fourth, though, had this been so, our Bear would have been a "high-stepper" of most unursine agility.

Underneath the three stars which make the handle of the Plough, or tail of the Bear, is a bright star, easily recognized from the comparative bareness of the region in which it is placed, which is known as Cor Caroli, "Charles' Heart," so called because Sir C. Scarborough declared that it shone with peculiar brightness the night before Charles the Second made his entry into London on his restoration. This name, however, attaches only to the single star; the constellation like Lynx and Leo Minor, being one of those which we owe to the ingenuity of Hevelius, who named it Canes Venatici, the "hunting dogs." Cor Caroli is a beautiful double star, the components of which are about 20" apart.

Below Canes Venatici, and immediately to the east of the rectangle of Leo, is a constellation which, though ancient, is by no means one of the original ones. Though it possesses no bright stars, yet on a clear night the region will attract the attention of the sharp-sighted observer, for delicate points and films of light are crowded in it. Serviss writes of it:—

"You will perceive a curious twinkling as if gossamer spangled with dewdrops were entangled there. One might think the old woman of the nursery rhyme, who went to sweep the cobwebs out of the sky, had skipped this corner, or else that its delicate beauty had preserved it even from her housewifely instincts."

The story of its naming is that Berenice, the Queen and sister of Ptolemy Euergetes, vowed her beautiful hair to Aphrodite, should her consort return safely from an expedition on which he had set out. The consecrated tress was, however, stolen from the temple soon after its dedication, and the consequences might have been very serious had not the royal astronomer of Alexandria, Conon, risen to the occasion, by declaring that Aphrodite had caught the tress up to heaven, in proof whereof he pointed out the constellation to the king and queen. Probably, however, the stars in this region had already a half-recognised position as forming a separate constellation, and the quick wit of the astronomer but confirmed a brevet rank.

CONSTELLATION-FIGURES AS GREEK COIN-TYPES.

By Robert Brown, Junr., F.S.A.

That nearly the whole of our ancient constellation-figures are to be found as types on coins will be admitted by anyone who is familiar with the subject. But of course the question for consideration is, Do they so appear *as* constellation-figures? A numismatic Ram has no necessary connection with the zodiacal *Aries*. We should require very strong evidence to show that a flaming Altar contained a reference to any constellational *Ara*, and so on. Here, as elsewhere, everything is a matter of evidence; nothing must be assumed, everything is possible. The next step to be noted in the enquiry is that various constellation-figures, *e.g.*, the Signs of the Zodiac, have undoubtedly appeared, as such, on coins. The twelve Signs are to be found on coins of the Roman Empire, as on coins of the Emperor Jahângir,(1) the *Capricorn*, as the fortunate Sign of Augustus, being specially prominent. Then, turning to the earlier Greek coins, we find that all over Hellas, from Italy to Pontus, constellation-figures appear as coin-types in astonishing numbers and with the greatest persistency. Do they, then, here appear in some cases as constellations? So far, this would seem to be by no means improbable. But several general theories of the origin of coin-types, exclusive of any astronomical connection, have been suggested. Thus, it is said that man put on his coins what he saw around him. He saw a lion, a lion tearing an ox, etc., and stamped representations of these on his coinage. Yes, but he did not see a gryphon, or a Pegasus, or a naked man with a club and lion-skin fighting against a many-headed snake and a crab. So we see that this theory will not enable us to explain either constellation-figures or coin-types as a

(1) Vide E. W. Maunder, *The Zodiacal Coins of the Emperor Jahângir, Knowledge*, July 1, 1896.

whole. Again, it is said that man stamped on his coins images of trade and barter, *e.g.*, sheep, oxen, goats, the *silphium* plant, and so on. But, I fear that if we attempt any general explanation of ancient coin-types on this principle we shall be landed in great difficulties. We cannot admit a trade in gryphons and man-headed bulls, in serpents, scorpions or eagles. We shall find on early coins-types, as elsewhere, symbolism and imitation; and if heaven can help us to understand them in some degree, let us not disdain its assistance.

The use of constellation-figures as coin-types has been treated of, to some extent, by M. Svoronos and Prof. D'Arcy Thompson, and also by myself in a recent work.[2] But what has been said is mainly preliminary, and the subject is still almost virgin ground. I propose to illustrate it here by a few examples; and, before referring to these in detail, would observe that I follow the descriptions of the subjects of the coins given by the British Museum experts. I would also remind the reader that nearly the whole of the forty-eight ancient constellation-figures of the Greeks were borrowed by them from their Eastern neighbours; and that very many of these figures appear as constellations in the literature and art of the Euphrates Valley.[3] Turning, then, to the particular examples before us, we find[4]:—

No. 1. *Herakles kneeling.* 'Herakles bearded, naked, kneeling on one knee, r.' With club, strung bow and two arrows; behind, Tunny. Cyzicus. Cir. B.C. 500—450. Every Sign of the Zodiac, except *Aquarius*, and other constellation-figures, whether as such or not, appear on the coins of this city, which, through Miletus and Lampsacus, is connected with Crete and Ph. influence. We know from Panyasis of Halicarnassus (ob. cir. B.C. 457), that the constellation which Aratus calls the *Kneeler* (*Engonasin*), was called *Heraklês*=Ph. *Harekhal* ('the Traveller'). Amongst the names of this constellation are *Meligartus* (=Gk. *Melikertes*, Ph. *Melqirth*, 'King-of-the-City'), *Malica* (=Ph. *Melekh*, 'the King'), *Palæmon* (=Gk. *Palaimon*, Ph. *Baal-Hamon*, 'the Burning-lord'), and *Macerus* (=*Makar*=*Melqarth*). A good instance of the type is the fine kneeling Herakles of the Ph. Thasos;[5] but the prototype is the Euphratean Gilgamesh (Gk. Gilgamos, Aelian, xii. 21), the 'giant-king,' who so frequently appears in Euphratean art bearded and kneeling on one knee, contending with a Lion, whose skin, in Hellas, he, as Herakles, wears or carries. In *Tab. No.* 83—1—18 *Gis* 'the constellation of the *King*' (Sumero-Akkadian *Mul Lugal*, Bab.-Assyrian *Kakkab-Šarru*) appears above 'the constellation of the *Scorpion*,' as on our own Globe.

No. 2. *Herakles with Hydra and Crab.* 'Herakles striking with club held in r. hand at Hydra which rears up before him, and whose nearest head he grasps with his l. hand; at his feet crab; over his l. arm, lion's skin.' Phaestus (Cir. B.C. 431-350). The story of the fight is told by Apollodorus (II. v. 2). A great scholar once said to me that if I had tried to invent a tale to support my view, I could not have hit on anything so perfect. According to Pausanias (II. vi. 3), Phaestus was a son of Herakles who taught the people of Sicyon to sacrifice to his sire, not as a hero but as a god (Ib. x. 1). Here we note the introduction of the cult of a foreign divinity. The *Hydra*, *Crab*, *Lion* and *King* were known as constellations in the planispheres of Babylonia and Phoenicia. As I have shown elsewhere, they originally represented certain archaic and pre-constellational ideas. Phaestus was one of the most ancient cities of Crete (*cf.* Il., ii. 648), and one of the three said to have been founded by Minos. Sacred symbols such as these must have been familiar long ere they were reproduced on coins. Hence, we see here on a coin an archaic legend which had already been transferred to the skies, *i.e.*, we have constellation-figures as coin-types. The *Lion*, *Crab* and *Water-snake* of the modern globe preserve the story. *King Heraklês* could not be placed next them, even in the Bab. Sphere, as he had already been located elsewhere. These obvious instances justify us in presuming a probable, or almost certain, connection between constellation-figure and coin-type where, at first sight, the evidence may not be quite so clear. Herakles is perhaps the most familiar coin-type throughout Hellas.

No. 3. *Herakles with Bow, Arrow and Birds.* 'Herakles naked, kneeling r. and discharging arrow; before him two birds.' Lamia (Thessaly), B.C. 350—400. This scene is still better depicted on the familiar gem which shows Herakles naked, kneeling on r. knee, Lion's skin over his l. arm, discharging arrow at three birds fronting him in a row. Here we have actually a combination of five constellations, very much as they appear on our globe to-day, *i.e.*, *Heraklês*, the *Man kneeling*, discharging his *Arrow* (*Sagitta*) at the three birds, the *Vulture* (*Lyra*), the *Swan* (*Cygnus*), and the *Eagle* (*Aquila*). The ancient little constellation the *Arrow* affords an excellent illustration of the mistaken views which formerly prevailed about these heavenly forms. The great K. O. Müller tells us that there is 'nothing mythological' about it, and that it was named from its 'figure.' Had he been asked, Why then, was it not called the *Lance* or the *Sceptre*? he could have given no answer except that men chose to call it the *Arrow*, which would be merely to repeat the fact that the ancient Greeks knew it as the *Arrow*, just as we do. As soon as we know the facts, we see why it was called the *Arrow*, and not the *Lance* or *Sceptre*, and observe that it was altogether mythological. This contest of Herakles (Vide No. 4) had its prototype in the fight between the Bab. Merodach and the three demon birds,[6] *i.e.*, the contest between the Sun-god and the Clouds of storm and darkness. The *Eagle*, the *Kite* (=*Ornis*=*Cygnus*) and the *Lammergeier* appear on the Bab. Celestial Sphere in front of the kneeling *King*. The simple nature-myth had already in the Euphrates Valley been transferred to the starry skies.

No. 4. *Heraklês and Bird.* Ob. 'Head of young Herakles in lion's skin. Rev. Head and neck of crested water-bird.' Stymphâlus (Arcadia), B.C. 431—370. Near this very ancient town (*cf.* Il., ii. 608), the name of which is derived from the Ph. *Stembal*, contracted from Mastanabal ('prob. *Clypeus Baalis*,' *i.e.*, the 'Bœotian Buckler' of Heraklês), was located the scene of the contest between Herakles and the demon birds (Paus. VIII. xxii. 4). In the mythic pedigree, Stymphâlus is said to have been the great-grandson of Arcas ('the Bright' = the *Bearward*), son of Callisto ('the Most-beautiful', = the *Great-bear*.

No. 5. *Bear.* 'Bear l. walking.' Mantineia (Arcadia). Before B.C. 471. Another coin shows the 'type l.; countermark, star.' The nymph Callisto 'made into the stars

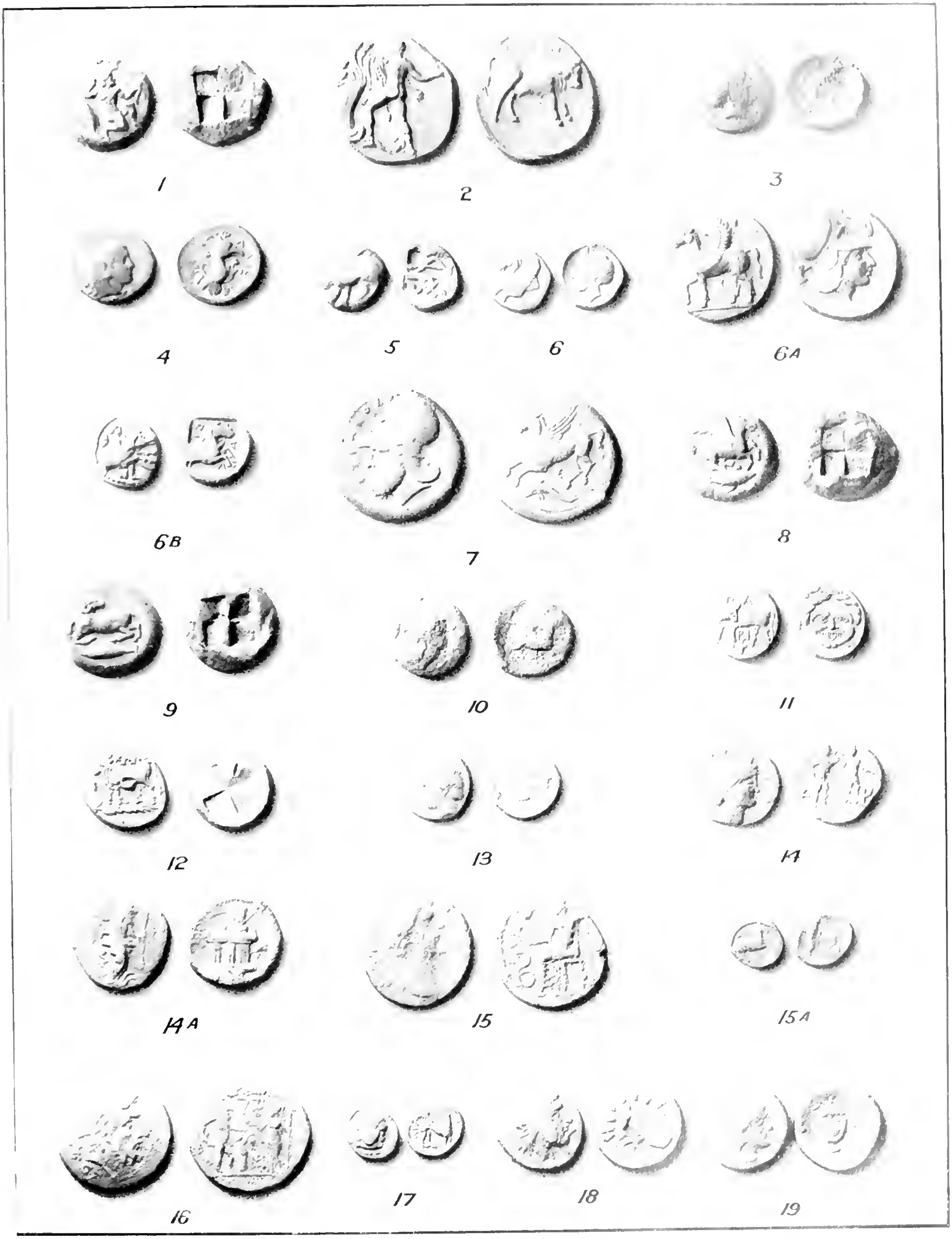
[2] *Pr[illegible] Constell[illegible]* [illegible] 1-24.

[3] Vide *Ibid.* passim.

[4] As the writers I quote [illegible] systems of spelling proper names, I do not pretend to uniformity in the matter in this Paper. [illegible] letter in scientific works to write proper names in their original [illegible], *e.g.*, not to clothe a Greek name in a Latin dress, or a Bab[illegible] name in a Hebrew or Greek dress. [illegible] abbreviations [illegible] Bab. = Babylonian, Ph. = Phoenician, Gk. = Greek.

[5] Vide Svoronos, *Types* [illegible].

[6] Vide Lajard, *Culte de Mithra*, Pl. lxi. 7.



CONSTELLATION FIGURES ON GREEK COINS.

called the *Great Horse*' (Paus. VIII., [illegible], Vide No. 4). The mythic legend is, of course, vastly older than the coinage.

No. 6A. *Pegasos.* 'Pegasos bridled, with curled wing, walking l.' Corinth. B.C. 400—338. The type appears on the earliest Corinthian coins, B.C. 650. 'The constellation of the *Horse* occurs in the Euphratean star lists and in Euphratean art.'[7] The Winged-horse was 'familiar to the imaginations of Mesopotamians.'[8] The creature also occurs on a well-known Hittite seal, figured by Wright,[9] Lajard, and others; and appears on coins of Lycia, and on those of the various Corinthian colonies. Sometimes, as in the heavens, a Demi-horse winged is shown, *e.g.*, on coins of the Ph. settlement Lampsacus ('the Passage,' *i.e.*, across the Hellespont). Corinth was the abode of Hipponoos ('the Wise-horseman') commonly called Bellerophon (= Ph. Baal Raphon, Bérard). Pegasus is the Horse 'bridled' (Sem. *Pegah* 'Bridle').

No. 7. *Pegasus and Fish.* 'Pegasus flying; beneath, Dolphin,' an adjacent constellation. Syracuse. B.C. 345. Earlier type *Demi-horse and Fish*, a Ph. coin of Panormus. A combination of *Pegasus* and the *Foremost Fish* in *Pisces*.

No. 9. *Ram and Fish.* 'Ram kneeling l., head turned back; beneath Tunny.' Cyzicus. Cir. B.C. 500—450. It was supposed that the zodiacal *Ram*, the 'pecudem Athamantidos,'[10] the Ram of Athamas (=Tammuz, the Semitic Sun-god), had carried Helle across the Hellespont, near the city. *Aries* has always been represented with reverted head. Thus, Manilius, i. 263-4:

> 'Aurato princeps *Aries* in vellere fulgens
> *Respicit*, admirans aversum surgere *Taurum*.'

The Northern of the two zodiacal *Fish* 'the Chaldeans call Chelidonias,'[11] the Tunny. There was an important tunny-fishery at Cyzicus, which would influence the choice of symbols.

No. 10. *Ram.* 'Helle seated sideways on ram flying r.' Alus (Thessaly). B.C. 400. Alos, otherwise Aleus (*i.e.*, 'Ram-town,' Heb. and Ph. *Ayil*, Bab.-Assyrian *Ailar*, 'Ram'), was said to have been built by 'the hero Athamas.'[12] The Ob. bears the head of Zeus Laphystius ('the Gluttonous,' *i.e.*, the Ph. Baal Kronos), to whom human sacrifices were offered. In the time of Pausanias (IX. xxxiv. 1) the spot was still shown in Bœotia where it was said Athamas was about to sacrifice Phrixos and Helle to Laphystius, when they escaped upon the Zeus-sent ram. *Kusariqqu* ('the *Ram*') was the first of the Bab. Signs of the Zodiac. This flying Ram is plainly not a specimen of the ordinary sheep, which men were supposed to put on coins because they saw them around, or bartered them.

No. 11. *Bull and Grapes.* 'Bull standing; beneath, bunch of grapes.' Parium (Mysia). B.C. 400—300. A colony of Miletus (Vide No. 1), Paros, and Thasos, Ph. centres. The *Clusterers* (*Pleiades*) are frequently represented in coin symbolism by a cluster of grapes (βότρυς). 'They are called a grape-cluster.'[13] A coin of Mallos in Cilicia shows doves whose bodies are formed of bunches of grapes, 'the dove-emblem and the grape-emblem of the Pleiad being here united or intermixed.'[14] Prof. Thompson well [illegible] [illegible] between [illegible] 'a kind of wild dove,' [illegible] wine, and the Semitic *gonath*, [illegible] 'dove' [illegible] form a commingling of etymological [illegible] similarity of sound such as symbolism del[illegible] [illegible] *grape-cluster* also appears on coins of Arvad [illegible] in the latter instance with a 5-rayed sta[r] [illegible] So, again, on the coinage of [illegible] we find 'Bull's head. Rev. Grape-cluster.'

No. 12. *Bull and Ear of corn.* 'Bull standing [illegible] of corn.' Calchedon. Cir. B.C. 400—350. The Ear-of-corn has been from remotest times a symbol of the goddess Ishtar (Astarte-Aphrodite), the original zodiacal *Virgo*, with her star *Spica*. Both the goddess and the Bull have a primary lunar connection, and this exact combination of Bull and Ear-of-corn appears on Euphratean cylinders of remote antiquity. The scene is not a bull in a cornfield, but a bull standing on a single ear of corn nearly as big as himself.

No. 13. *Demi-bull.* 'Forepart of rushing bull.' Magnesia ad Mæandrum. Cir. B.C. 350—190. Another coin shows 'Humped bull butting.' We have already met with *Taurus* and *Pleiades* (No. 11), and *Taurus* and *Spica* (No. 12). Here is the exact zodiacal *Taurus*, demi, gibbous, and with bent leg. The farmer would not notice demi-bulls and demi-horses in his fields. The moon-bull is, of course, at times demi; as is the solar Horse, when he rises and sets, especially from or into the sea.

No. 14. *Twins.* 'Altar or shrine surmounted by the busts of the Dioscuri, wearing *pilei*, their heads and shoulders appearing over the top.' Mantineia. B.C. 431—370. We also find 'Two male figures (the Cabiri) standing facing, their right hands resting on their hips.' Syros. Third to first century B.C. Another type is '*Pilei* surmounted by stars,' *i.e.*, the 'fratres Helenae, lucida sidera,'[16] Castor and Pollux. The Euphratean name of the constellation was 'the *Great Twins*.' I believe the *Twins* are sometimes represented by Harmodius and Aristogeiton as on a coin of Cyzicus, a city which shows eleven Signs of the Zodiac on its coinage (Vide No. 1).

No. 15. *Snake-holder.* 'The Asklepios of Thrasymedes.' Epidaurus. A reproduction of the earlier coin-type of B.C. 323-240. The famous statue of the god, with his hand on his serpent's head, is described by Pausanias (II. xxvii. 2). On the Ph. coinage of Kossura a 'Cabirus' (Ph. *Kabirim*, 'the Great-ones') is depicted 'serpentem tenens.' This personage is the 'native Ph. god'[17] Eshmun ('the Eighth' of the Kabirim), whose name, in a trilingual Inscription of Sardinia,[18] is rendered 'Asklepios' and 'Aescolapeus.' He was a great patron divinity of Epidaurus, and was there regarded as the constellational Snake-holder.[19]

No. 16. *Cepheus.* 'Pallas and Cepheus, both armed, standing face to face, the goddess hands to the hero the head of Medusa; between them, Sterope r., who holds up a vase to receive it.' Tegea. After B.C. 146. Pallas, Medusa and Sterope appear in the same connection on earlier coins. Local legend: Pallas promised Cepheus, son of Aleus (Vide No. 10), that Tegea should never be captured, and gave him one of the locks of Medusa as a protection for the city.[20] The local [illegible], like so many recorded by Pausanias, is an attempt to explain facts

Vide R. B. Jr. *The Heavenly Display*, Fig. xx.

Perrot, *Hist. of Art in Chal.*, ii. 171. Vide Fig. 89, 'Winged Horse.'

Empire of the Hittites, Pl. xvi.

Ovid, *Fasti*, iv. 903.

Schol. in Arat. *Phainom.* 242.

Strabo, IX. v. 8; vide No. 9.

Schol. in *Il.* xviii. 486.

D'Arcy Thompson, *Bird and Beast in Anct. Sym.*, [illegible] p. 18[illegible]

Vide R. B. Jr. *The C[illegible]* [illegible] Fig. 7, p. 11.

Horace, *Car.* I. iii. 2.

Damaskios, *Pecharin* [illegible]

Corp. Ins. Sem. cxliii.

Vide *Kabas*, vi.; [illegible] [illegible] *Phoen.* ii. 14; etc.

Paus. VIII. xl. iii. 4.

the real meaning of which had long been forgotten. This Cepheus, who was ultimately supplied with a pedigree from Lycaon (*i.e.*, the votary of Zeus Lycaios),[21] Callisto (the *Great-bear*), Arcas (1. 'Le dieu-soleil,' and 2. The *Bearward*) and others, is really identical with the Ph. and constellational Cepheus.[22] We have here a remarkable picture of a portion of the heavens. *Cepheus*, who was also Baal Tsephôn ('Lord-of-the-North'), from near the Pole, drops, as it were, *Medusa's Head* (*i.e.*, the star *Algol*, 'the Ghoul,' evidently so styled from its extraordinary variations in brilliancy) into the vase held up by *Sterope* ('the Bright' or 'Lightner'), one of the *Pleiades*, immediately beneath.

No. 17. *Virgin and Dog.* Ob. 'Head of Aphrodite of Eryx.' Rev. 'Hound looking back.' Period of transition. Town finally destroyed in the first Punic War. A very ancient seat of the Ph. cult of 'Aschtharth Erek-hayim ('Astarte longæ vitæ auctor'), called Aphrodite Erykine,[23] and, in Attica, Erigone, who, according to the Athenian legend, was changed into *Virgo*, and her faithful little dog, 'canis ululans Meta,'[24] Maira ('the Sparkler'), into *Procyon*. Dogs were sacrificed to the Ph. goddess 'Aschtharth Melekhet[25] Aschamaim ('Astarte, Queen of heaven') = Aphrodite Ourania.

No. 18. *Sirius.* 'Forepart of dog l. surrounded by rays, Sirius.' Ceos. Second Century B.C. Very early coins of Carthaea, the ancient Ph. capital of the island, bear (1) an *Amphora*, which from the Bab. Cylinders downwards, is a frequent symbol of *Aquarius*; or (2) a *Dolphin*, the fish sacred to the Ph. Poseidon; or (3) a *Bunch of Grapes* (Vide No. 11). Local legend:—Aristæus prays to Zeus and *Sirius* against the plague. Other coins of Ceos bear a Star (*Sirius*) only on the Rev. The cult of astral divinities is not naturally Hellenic.

No. 19. *Perseus.* Ob. 'Helmeted head of Perseus r.' Rev. 'Gorgon's head: beneath, *harpa* r.' Seriphos. Cir. B.C. 300. Perseus was especially honoured here.[26] The scimitar or sickle with which the Bab. Merôdach is armed in his fight against the Dragon, reappears as the sickle used by the Ph. Kronos against Ouranos. This weapon, called in Canaanite *khereb*, a word which the Egyptians borrowed in the form *karp*, is the *harpê* which the Ph. Perseus uses against the *Sea-monster* (*Cetus*), which latter constellation-figure appears on the coins of Itanos (Crete) and Agrigentum. The whole story of Cepheus, Cassiepeia, Andromeda and Perseus is Phœnician.[27]

Such are a few instances of Greek constellation-figures as coin-types. How they got there is no legitimate cause for wonder. Their absence from the coins would have been truly remarkable. For, the great historical fact underlying the whole matter is simply that at an early period, long before coined money, Semites skilled in letters, navigation, astronomy, etc., invaded Hellas; and that the Greeks, the quickest of mankind, promptly absorbed this knowledge, reproduced and bettered it. The Greeks themselves were not naturally stellar votaries. Their great Aryan divinities, Zeus, Hera, Aidoneus (= Pluto), Demeter, Hestia, Hephaistos, Apollo, Athena, Artemis, Hermes, Pan, etc., do not appear as sky-figures. It is the Phœnician personages, Poseidon (= the *Charioteer*),[28] Herakles (= the *Kneeler*), Eshmûn (= the *Snake-holder*), Aphrodite (= the *Virgin*), Cepheus and his family, Arcas (= the *Bearward*), etc., with sacred animals of Western Asia, *e.g.*, the Bear, Serpent, Horse, Lion, Dog, Eagle, Dolphin, etc., that we find sphered on high. And, lastly, history, archaeology, and astronomy unite in showing that a region of which Babylon was about the southern point, was the primitive home of most of the constellation-figures which we have received through the medium of Greece.

NOTE.—The following coins are also shown on the Plate:—

No. 6. *Pegasus.* Corinth. Cir. B.C. 431—338. Rev. Head of Astarte-Aphrodite.

No. 6B. Rev. *Pegasus.* 'Forepart of bridled horse galloping r.' Larissa (Thessaly). B.C. 480—450.

No. 8. Ob. *Pegasus.* 'With pointed wing flying r.: beneath tunny.' Cyzicus. B.C. 450—400.

No. 14A. *Twins.* Rev. 'Altar surmounted by the busts of the Dioscuri l., wearing *pilei*, their heads and shoulders appearing over the top.' Mantineia. B.C. 431—370.

No. 15A. *Snake-holder.* Rev. 'Asklepius feeding serpent from *patera*.' Larissa. B.C. 450—400. The Horse on the Ob. may be *Pegasus* (Vide No. 6B).

The Ph. Light-god (Vide Bérard, *De l'Origine des Cultes Arcadiens*, p. 49 *et seq.*).

Ph. *Keph*, the sacred 'Stone.' [illegible]

Paus. VIII. xxiv. 6.

Hyginus, *Fab.* cxxx.

Vide Movers, *Die Phœnizier*, i. 404.

Paus. II. xviii. 1.

Vide Gruppe, *Der phoinikische urtext der kassiepeia legende*, 1888.

Vide R. B. Jr., *Primitive Constellations*, i. [illegible]

THE CANALS OF MARS.

By Miss M. A. ORR.

THE physical condition of Mars is a problem over which discussion still rages with unabated vigour. While Mr. Lowell sees in the Martian "canals" a vast system of artificial irrigation, and M. du Ligondès geological fissures, through which rise to the frozen surface vivifying vapours from a still heated interior, M. Antoniadi ascribes their doubling to a defect in focussing, and others disbelieve in even their single existence. But the enigmatical lines have appeared to so many, and in the main with such consistent similarity, that the ranks of these unbelievers grow thin. Between rejecting the canals altogether, however, and accepting them as actual physical entities, there are other possible alternatives. Mr. Walter Maunder, in an article in KNOWLEDGE for November, 1894, and more recently Signor Cerulli, in recounting his observations of Mars in the opposition of 1896-7, at his private observatory of Collurania (Teramo), showed how the mathematical lines and spots we find in the faint markings of Mars might be merely the easiest form in which, with our present optical means, we could be cognizant of its real features. This latter treatise elicited replies from Schiaparelli and Flammarion, but their arguments in favour of the physical existence of the markings as such, and of actual changes taking place in them, are not altogether conclusive. Signor Cerulli's observations during the last opposition have confirmed him in the belief that the markings are optical, and his new report* is substantially a full exposition of his theory. These observations extended from August, 1898, to March, 1899, and were made with a 15½ in. Cooke equatorial, with powers of 400 and 500, always without stops or coloured screens, the object being not to get sharp definition of any special feature, but as complete a picture as might be of all the phenomena. The author shows what is the explanation, on his theory, of the features seen and their apparent variations, and brings forward ingenious and novel arguments to prove his case.

It must be remembered that in a bird's-eye view of a

* Nuove osservazioni di Marte: Saggio di una interpretazione ottica delle sensazioni areoscopiche. By V. Cerulli. Collurania, 1900.

world some 40 millions of miles away all we can take note of are contrasts in tone and colour, while the real contour of objects is masked or invisible. Small or faintly-shaded objects, invisible singly, will produce an effect, if close together, of one large mass, and from our inability to see the irregularity of their grouping, will appear as round spots or long streaks. But conditions of seeing vary enormously on Mars, according to its distance and position, and the changing illumination of its disc; not to speak of variations in ourselves, our atmosphere and our instruments; the contrasts, therefore, will vary, more detail will sometimes be seen in the patches and streaks, fainter markings at their edges will appear and disappear, altering their outline and extent. The hazy aspect of Schiaparelli's canals may thus be a nearer approximation to reality than the sharply defined, and the doubling may be due to disappearance of faint shadings between more easily grasped boundaries. That the canals were discovered after the opposition of 1877, being only suspected during the most favourable period, that they are sharpest with coloured screens and comparatively small apertures, while in the great Lick and Washington telescopes they have been seen either as few diffused markings, or not at all, suggest that the fine lines are simply a mode under which faint markings may present themselves to imperfect vision. There is undoubtedly truth in the apparent paradox that greater distinctness comes with poorer vision, for in the best moments the eye dimly perceives, even where it cannot grasp, divisions in simple masses, curves and blurring in narrow lines, indeterminate shadows in clear spaces.

Whether the optical theory accounts for *all* the variations, including those of the polar caps, the future must decide. Most interesting is Cerulli's appeal to the past history of areography, referring to Flammarion's valuable collection of drawings, all carefully copied from originals, in his "Planète Mars." Here we may see how in the first rude telescopes impressions of Martian markings were summed up in one large round spot, or one wide band, which latter was by Cassini and some others seen double. By degrees the easiest features of the southern hemisphere were distinguished, but appeared so variable that an atmospheric origin was ascribed to them. It is particularly instructive to compare Knott's drawing of November 3, 1862, with Lord Rosse's of three days later. Knott's telescope was of $7\frac{1}{3}$ in. aperture, and the features which in the 6 ft. Rosse reflector appeared as large dark patches on a fainter background, he portrays as narrow lines on white—canals on a large scale. Again, in two excellent drawings by Kaiser, a broad band where we now recognise Praxodes, seen at the opposition of 1862, becomes, six weeks later, when seeing was more difficult, two narrow bands with faint shadings between. Other examples of gemination in lines and in spots, contractions and enlargements, etc., may be traced, and through all the series there is a remarkable, but in no wise astonishing variety of representation. One has but to consider the fugitive faintness of the objects, the imperfections of the instruments and the personality of the observers, which affects not only their vision but their mode of portrayal. On this last point, which comes out very clearly on an examination of the illustrations in "La Planète Mars," Signor Cerulli has not perhaps laid enough stress, nor on the influence of unconscious imitation.

Mr. Green, the artist astronomer, used to insist on the importance of the trained hand as well as the trained eye in order to obtain true pictures of planetary detail.

Is the history of discoveries [illegible] regard to the large markings in Mars' southern [illegible] repeating itself now with the more delicate [illegible] northern? and with better optical means would [illegible] their misleading appearance of mathematical [illegible] and their instability?

The artificial origin of the Martian "canals" can hardly be maintained now that they have been seen to traverse the polar caps, and to appear in Venus, Mercury, and two of the Jovian satellites. On the optical hypothesis, on the other hand, this is precisely what we might expect. It is perhaps going too far to suggest that the bands of Jupiter and their varying appearances are strictly analogous to canals, since their atmospheric origin is rendered probable by other considerations, notably by the planet's low density; yet there is certainly a startling resemblance between some early drawings of Mars and recent diagrams of Jupiter. Schröter's Mars, for instance, on page 77, Fig. 48, of "La Planète Mars" (1892 edition), tempts one to quote Dante:—

> † "Such would Jove become, if he and Mars
> Were birds, and changed their plumage."

We are indebted to M. Flammarion for another line of evidence. He had the happy idea of collecting naked eye views of the moon by different observers, and in response to his appeal an interesting series appeared in the "Bulletin de la Société Astronomique de France," from January to June of last year. The disc of the moon to the unaided eye is about the same size as that of Mars in an average telescope, but the conditions are not quite the same, as naked eye vision does not admit of straining and mis-focussing to the same extent as telescopic. Nevertheless, the study of these drawings is, as M. Flammarion remarks, a lesson on the value to be attached to observations at the limit of visibility, and no one would have believed that the same thing could have been represented in so many different ways. The reader may judge for himself by personal examination whether these drawings support Cerulli's theory of the canals. He will not fail to observe a tendency to draw the Seas of Serenity, Tranquillity, Plenty, and Nectar, as two lines more or less parallel, while the Ocean of Tempests is sometimes a narrow curved line, its eastern border only being seen, in contrast with the brilliant limb. Tycho in one instance appears as a very large bright *square*.

Whether the optical theory be correct or no, probably no one will deny the wisdom of Signor Cerulli's advice to regard all Martian maps as temporary guides, sure to be modified by further investigation. We may add, however, that to refrain altogether from speculative hypotheses would be as unscientific as uninteresting; the sensational theories about Mars have been a stimulus to much excellent work; but the scientist remembers that they are only theories, and is prepared to see them dispelled by fuller light.

Letters.

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

GRADUAL CHANGE IN OUR CLIMATE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Is our summer [illegible] London getting [illegible]

† Qual diverrebbe Giove, [illegible]
Fossero augelli [illegible] Par. xxvii. 14 15.

and drier? I would invite attention to the following facts in this relation:—

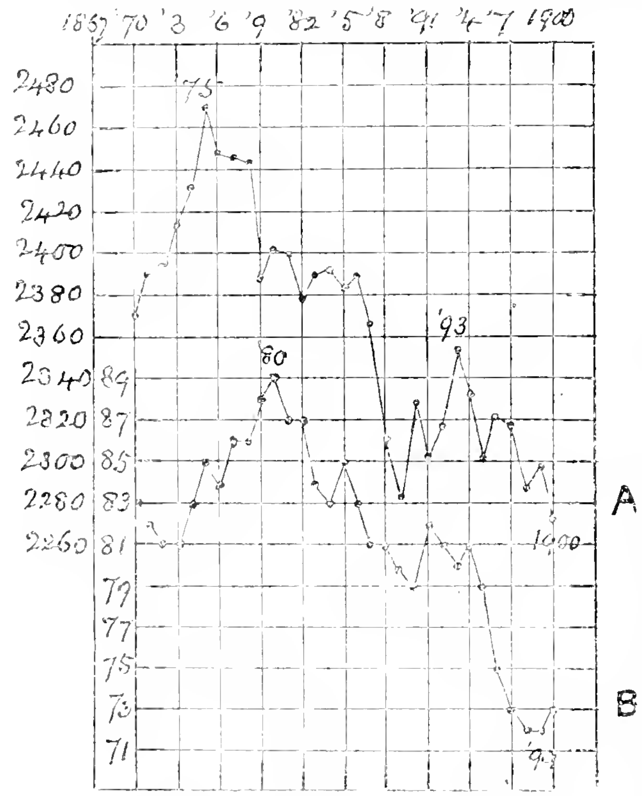
1. The last 30 years (1871-1900) contain a smaller number of days with maximum temperature, 70° or more, than any other 30 consecutive years since 1841. (Of such groups there are obviously 31.)

Curve A shows the general decline in those values. The first year-point represents the number of those hot days in the 30 years ending 1870, the next in the 30 years ending 1871, and so on. The difference between the highest and the lowest point is 2470 – 2273 = 197.

Next, let us consider the number of wet months in the summer half (April to September) in 30 years ending 1870, '71, &c. We have the curve B, showing also a general decline. We may say this about it:—

2. In each of the 30-year groups ending 1898 and '99, the number of these wet months was less than in any other group (than these two) of 30 consecutive years since 1841. (The value for 1900 shows a slight rise.) The difference between the highest and the lowest value is 89 – 72 = 17.

I do not represent that this gradual decline is likely to continue. More probably we shall ere long find compen-



A. Days with maximum temperature 70° or more in 30 years ending 1870, '71, etc.
B. Wet months in summer half in 30 years ending 1870, '71, etc.

sation, and a rise in the curves. It seems desirable to get light on the limits and cause of those variations.

ALEX. B. MACDOWALL.

RAINBOW PHENOMENA

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The double rainbow observed by Mr. S. R. S. Brown at Eastbourne, and recorded in KNOWLEDGE for December, 1900, must have been a very good example of what are called "supernumerary" bows, and which are said to be due to interference (see Scott's "Elementary Meteorology," p. 200, 1st Edition), but I would like to see the mathematical proof of this.

I have often noticed these supernumeraries, but never more than three inside the primary bow. It would be interesting to know if any one has ever observed the same thing in connection with the secondary bow. Sometimes the bow has been nearly the complete semi-circle, and at others and more commonly only a very small segment of the bow was projected above the horizon. One especially which I observed in Essex a good many years ago was very brilliant, and the third or inmost supernumerary only just cleared the horizon. I fancy they are always present and to be seen provided the sun's rays are bright enough and the background of cloud is dark enough.

On the 26th September last I saw a rainbow which besides exhibiting the supernumerary bows had another variation, which I described as follows in my weather record:—"The bow seen at 5.30 p.m. showed inside the ordinary primary, and close to it two supernumerary or interference bows; at about half the height of the bow a short piece of the supernumerary bows was broken from the circular band of the bows, and stood at an angle of 15° to 20° from the circle of the bows. The whole bow was standing against the streaky cloud rays which accompanied a shower that had just passed over, and these streaks seemed to be in some degree parallel to the broken piece of the supernumeraries."

As to the cause of this there must have been a reflection of the sun's rays in some way.

I should add for the further information of those interested that the ground to the west rises gradually, and that the clouds on which the bow was projected were over Lake Temiscamingue, which gave me a good view of the phenomenon. PAUL A. COBBOLD.

Haileybury, Ont., Canada,
December 16th, 1900.

"IS HUMAN LIFE POSSIBLE ON OTHER PLANETS?"

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Your correspondent A. D. Taylor enquires in the January number of KNOWLEDGE as to whether those who have made a study of the planets can throw any light on the above subject. He especially calls our attention to the planet Mars, a planet which he has hitherto considered suitable for the maintenance of human life. In passing rapidly over these controverted subjects we may say that the greater part of the surface of this planet is desert, that the water supply is very scanty,—the greenish looking patches on the planet, which have hitherto been considered seas, are, according to Mr. Percival Lowell, nothing but large tracts of vegetation growing in the bottoms of the old seas. The inhabitants, if such there were, would be dependent for their water supply from the annual melting of the polar snow or hoar-frost. The atmosphere is thin, and consequently free from clouds; it is doubtful whether there are any rainfalls on the planet, the moisture being deposited in the form of dew or hoar-frost. The question of the composition of the Martian atmosphere is of the greatest importance. Your readers are aware that the chemical composition of any atmosphere is dependent on the critical temperature and the critical velocity of its gases. In other words, if the gravitational pull of a planet is not greater than the critical velocity of its gases, the molecules of gas will leave the planet never to return. In the case of Jupiter, we find the atmosphere is exceedingly dense, while such bodies as Mercury and our own moon are practically devoid of atmosphere. It has been assumed that the atmosphere and water (converted into water-vapour) of the moon have been, by molecular motion, drawn down to the surface of the earth. If this be the case, therefore, we do not know what gases and vapours may not have been liberated from the surface of Mars. On this question, I think, the whole subject hangs. There is no reason for doubting that, given the necessary elements for the formation of living matter, the organic kingdoms may not have followed the same course of evolution as our own. The organisms are perhaps larger, owing to the lesser pull of gravity on that planet. In conclusion, I should advise Mr. Taylor to read Percival Lowell's admirable work on "Mars," if he desires to enter into the subject more fully.

Thomas R. Waring.

Liverpool.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In reply to Mr. Taylor's query I should say that most scientific men would undoubtedly give a very decided "No" to his question, and for the following two good reasons:—

First—There is not one chance in a million that any two planets among the unnumbered myriads that probably exist in space utterly unknown to us have, in the course of evolution, become so similar in their physical conditions as to be sufficiently fitted for the inhabitants of each other to be able to continue to maintain their existence if they interchanged worlds.

Secondly—Granting that the physical conditions of two planets may be sufficiently similar to enable most of the forms of life on the one to exist on the other, yet the chances against identical or even similar forms being found on both are immense. The almost infinite complexity of circumstances which, in the long course of evolution, has moulded living organisms on our earth to what they are will have acted equally on every other planet, and effectually precluded any two forms being similar except in the remotest sense of the term.

No doubt such planets as Mars are teeming with life, but each one with life peculiar to itself, fitted by Nature to the surrounding conditions, and no others. Looking to man, we see, as Sir Robert S. Ball remarks, that "he is a creature adapted for life under circumstances which are very narrowly limited. A few degrees of temperature, more or less, a slight variation in the composition of air, the precise suitability of food, make all the difference between health and sickness, between life and death."

Intelligence may—nay, probably has—a home on distant spheres, but in forms stranger than have ever been imagined by us.

Arthur Ed. Mitchell.

Oxenhope, nr. Keighley.

January 8th, 1901.

Notices of Books.

"Essays in Illustration of the Action of Astral Gravitation in Natural Phenomena." By William Leighton Jordan, F.R.G.S., etc. (Longmans.) 9s.—Mr. Jordan is by no means satisfied with the current opinions of men of science on the fundamental principles upon which the systematised body of knowledge called science is based. Though he has written other books, this is the first which has come under our notice, and from a somewhat careful reading the conclusion arrived at is that there is more valuable material to be obtained elsewhere. No good end would be served by dealing with each of the six essays in detail. It must suffice to take one as an example. This is called "Sir Isaac Newton and Modern Chemistry." One or two short quotations will serve the useful purpose of enabling the reader to form for himself an estimate of the value of Mr. Jordan's contribution to science. "Among the important advances [illegible] knowledge . . . there has been a tendency in the direction of showing that material substance exists only within a limited range of temperature—that is to say, that a considerable rise or fall of temperature will transmute any form of matter into immaterial force." (p. 159.) "Too limited a view seems to be taken of the extent and powers of nature in supposing material atoms to be unchangeable, for that idea in fact places these atoms above the powers of nature, and might indeed almost be said to make them nature's gods." (p. 161.) On page 162, "atoms of pure water" are spoken of. On page 180 occurs this statement: "Careful experiments in closed vessels have shown that this (increase in mass on oxidation) is due to a transmutation of air into metallic substance during the process of calcination; and in this case a return to normal temperature does not retransform the metal to air." For the present it would seem advisable to content ourselves with mere orthodox physics and chemistry.

"Lord Lilford (Thomas Littleton, Fourth Baron)." A Memoir by his Sister, with an introduction by the Bishop of London. (Smith, Elder.) Illustrated. 10s. 6d. Pending a more elaborate biography, Mrs. Drewitt has put together a brief memoir of her brother, the late Lord Lilford. It was as an ornithologist that Lord Lilford was chiefly famed. He was of too retiring a nature to publish much, but his works on the "Birds of Northampton," and his "Coloured Figures of the Birds of the British Islands" are well known, while a number of valuable papers from his pen appear in the *Ibis* and other publications. Although he had the grievous misfortune in the prime of his life to become a martyr to rheumatic gout, which confined him to a bath chair for practically the remainder of his days, he was an ardent sportsman, and a still more ardent lover and observer of nature. As a man he was generous and liberal in the extreme, and so unostentatious was his beneficence that the extent of it can never be gauged. His affliction caused him intense suffering, and, moreover, made him completely helpless, which to a man imbued with instincts of sport and travel must have been the deepest trial, yet he counted his life a happy one, and never complained of his lot. The most interesting part of this memoir will be found in the letters written at various times to his friends. They show the character of the man, as well as his intimate knowledge and great love of animal life, and especially of birds. The illustrations are chiefly of birds from the collection at Lilford Hall. There Lord Lilford had gradually brought together an extraordinary collection of live birds, which were kept in a state of freedom only second to nature. Many of these birds were of great rarity. Many he had obtained himself during trips to Spain and various parts of the Mediterranean. Some notes written for the Natural History Society at Northampton by Lord Lilford on his aviaries appear in the memoir, and will give an idea of the extent and richness of the collection.

"Problems of Evolution." By F. W. Headley. (Duckworth.) 8s. net.—Though Lamarckism is a century old, and Darwin's "Origin of Species" was published in 1859, naturalists are still divided in their opinions as to the causes which have determined the evolution of plants and animals. Lamarck maintained that external conditions modify the individual and that the next generation inherits the modification. Darwin showed how the struggle for existence could account for the survival and propagation of organisms which varied from the normal in characteristics best suited for the environment in which they happened to be. If the Lamarckian principle is true, then the part played by natural selection in producing new species is comparatively small, hence the two hypotheses oppose one another and provide much material for discussion. There are naturalists who accept the fundamental idea of Lamarck, but a much larger school follows Darwin and Wallace. A new epoch was commenced by Prof. Weismann, whose brilliant studies command the attention of biologists, even though objection may be raised to the doctrines which have grown out of them. "Weismann," to use Mr. Headley's words, "saw two very remarkable phenomena for which a theoretical basis must be found. First, heredity, the recognised fact that sons closely resemble their parents; secondly, the fact, as he himself considered it to be, that acquired characteristics are not inherited; that if the speed of a horse is increased by training, the increase of muscular power so obtained is not transmitted." Weismann has provided biological explanations of these phenomena, his chief generalisations being that the reproductive elements—the germ-plasm—of the higher organisms are immortal, while the rest of the body—the somatoplasm—dies. Such are baldly some of the chief speculations with which Mr. Headley is concerned. One of the main objects of the book is to show that the Lamarckian view has no basis in fact, and that it offers no explanation of the phenomena of animated nature. At the same time this is only one of the objects, for the volume consists of two parts, the second being taken up with the problems of human evolution. Human evolution is treated of under the headings of physical, moral, and intellectual evolution, and the question of physical degeneration is dealt with very fully. Mr. Headley writes in a stimulating and interesting manner, and avoids any partisanship very successfully. To anyone who wishes to read an up-to-date account of evolutionary theories, Mr. Headley's book can be recommended in full confidence.

"STUDIES: SCIENTIFIC AND SOCIAL." By Dr. Alfred Russel Wallace. Two volumes. Illustrated. (Macmillan.) 18s.—In these two volumes we have an epitome of Dr. Wallace's views on many subjects of science and philosophy, covering a period of about thirty-five years. The essays have appeared in reviews and other publications, and have not only been enlarged and simplified in places, but have also been given additional interest by numerous striking illustrations. There are, in the first volume essays on questions of physical geology, descriptive zoology, plant distribution, animal distribution, the theory of evolution, anthropology, and instinct; while the second volume contains contributions on educational, political, ethical, and sociological subjects. The ground covered is thus so extensive that it cannot be adequately surveyed in a short review; therefore we must content ourselves with mentioning a few of its prominent features. Dr. Wallace holds that the oceanic areas beyond the depth of 2000 fathoms, constituting about seventy per cent. of the whole ocean floor, have been ocean throughout all known geological time. There has been a large amount of controversy over this question of the permanency of the ocean bed, but in England a compromise seems to have been effected between the two schools of geologists. Dr. Wallace remains in possession of his 2000 fathom boundary—at least so far as Mesozoic and subsequent ages are concerned—but abandons his earlier limit of 1000 fathoms. He accepts the Rev. O. Fisher's conclusion that the average thickness of the earth's crust on lands near the sea-level is only about eighteen miles, which is all that separates us from a layer of molten lava. It can scarcely be said, however, that the data available are sufficiently exact to justify any very definite pronouncement upon this matter. The valley-lakes of highly-glaciated districts are believed by Dr. Wallace to have been formed by ice-action. This view of Ramsay's is maintained by a group of distinguished geologists but others—Prof. Bonney among them—explain the lakes as the result of earth movements and other causes. Wales, Scotland, Switzerland, Scandinavia, and North America all present an abundance of these lakes, and all of these countries have been subjected to glacial action. On the other hand, as Mr. Oldham pointed out some time ago, there are valleys in regions showing [illegible] glaciation, very similar to those in which lakes [illegible] with the débris of rocks instead of water, and [illegible] that they have been scooped out by glacier action. The zoological essays are most interesting to read and several of them set forth in the clearest possible manner the theory of the origin of species by means of natural selection. Dr. Wallace says that objections to the theory are often based upon [illegible] of facts of natural history. He will have [illegible] discontinuous variation or the inheritance of acquired [illegible] or any other modification or substitute for the Darwinian [illegible] as the method of organic evolution. His definite conclusion, after examining the cases put forward by naturalists who [illegible] Darwinianism, is that "no case has yet been [illegible] the inheritance of individually acquired characters, [illegible] variation and natural selection are fully adequate to [illegible] those various modifications of organisms which have been supposed to be beyond their power." No space is left even to mention the other subjects dealt with in the volumes: the disguises of insects, the distribution of animals, the functions of museums, the origin of speech, the nationalisation of the land, and other matters of human interest. There are fifty-two essays in all, and each of them will prove a source of instruction to the reader. Few men have wider sympathies with Nature than Dr. Wallace, and none have a more extensive influence.

"PUBLICATIONS OF THE LICK OBSERVATORY." Volume IV., 1900.—"Meridian Circle Observations of 310 Standard Stars." By R. H. Tucker.—This is a work of great importance for professional astronomers, being the systematic and repeated observation of the standard stars of the four great ephemerides of the United States, England, France, and Germany, carried out with the thoroughness and skill which are associated with Mr. Tucker's name. A full description of the instrument, of the methods of observation, and of the corrections, is given in the Introduction.

"WHO'S WHO, 1901." (Adam and Charles Black. 5s.—We suppose it will always pass the wit of man to set up a standard of distinction in the preparation of a work of this kind, but the continuous growth of a miscellaneous crowd of country J.P.'s, obscure M.P.'s, and still more obscure peers, will certainly necessitate some rule on the subject, or it may become a greater distinction to be out of the book than in it. Apart from this obvious danger to the utility of the work, it may be most heartily commended for its lucid and informing character throughout, and if it should happen that one wants to know anything about anyone at any time, then the information is most likely to be contained in "Who's Who." But there is such a distressingly large number of names of whom it may be safely said that few people will ever have any occasion to consult their record, to become interested in their orderly progress from the University to the Bench, or excited concerning their recreations. Still "Who's Who" is a great work, grateful to the journalist, and comforting to those included in its pages.

"THE ENGLISHWOMAN'S YEAR BOOK AND DIRECTORY, 1901." Edited by Emily Janes. (Adam and Charles Black.) 2s. 6d. net.—A truly remarkable record of the successful result of sustained effort. So far as we can see, covering the whole field of their activities, the book is an object lesson in the amazing advances of women during the past few years in every branch of human activity.

A copy of Darwin's "THE ORIGIN OF SPECIES" can now be obtained for the sum of 2s. 6d., Messrs. Murray having, on the approaching expiration of the copyright of that work, issued a cheap edition. The new book has a cover which will not shame any library, and is well printed on thin paper. That the mass of erroneous and harmful ideas which associate themselves in the popular mind with the name of Darwin will be replaced by clear perceptions of his theories is a hope too sanguine perhaps to be fulfilled. But to possess may mean to peruse, and Messrs. Murray have at least removed the excuses of those who have light pockets.

We have received from the Hon. Secretary of the Anthropological Institute a copy of the first number of a new monthly journal entitled "MAN," to be devoted to the record of progress made in the various branches of the study of mankind. The scope of the new periodical will include physical anthropology, ethnography, psychology, the study of language, and of the earlier stages of civilization, industry, and art, as well as the history of social institutions and of moral and religious ideas, so that there should be no lack of material wherewith to fill the allotted number of pages. A wise provision in the scheme is the concentration of attention on those sections of its subjects which at present suffer from lack of a journal devoted to their special interests. In addition to occasional text figures, each number will be illustrated with a full-page plate. That there is room for such a journal there can be little doubt, and the January issue promises well for the future. This part contains five original articles, one of which is illustrated with a coloured plate of the Japanese "Wheel of Life." These are followed by nine reviews from the pens of well-known authorities. Each article is headed by a short "subject-title" in large type, and is also marked with a reference number by which it should be quoted. The annual subscription for the general public is ten shillings. The new venture has our hearty good wishes.

BOOKS RECEIVED.

The Complete Works of John Keats. Vol. II. Edited by H. Buxton Forman. (Glasgow: Gowars & Gray.)

Text-Book of Zoology. Part III. *Invertebrates.* By Dr. Otto Schmeil. (A. & C. Black.) Illustrated. 3s. 6d.

Modern Chemistry—Theoretical. By William Ramsay, D.Sc. (Dent.) 1s. net.

Modern Chemistry—Systematic. By William Ramsay, D.Sc. (Dent.) 1s. net.

Practical Electroplating. By John A. Hodges, F.R.P.S. (Iliffe, Sons & Sturmey.) Illustrated. 1s. net.

Periodic Classification and the Problem of Chemical Evolution. By George Rudorf, B.Sc. (Whittaker.) Illustrated. 4s. 6d.

The Self-Educator in Latin. By W. A. Edward, M.A. (Self Educator Series.) (Hodder & Stoughton.) 2s. 6d.

Primer of Astronomy. By Sir Robert Ball, LL.D., F.R.S. (Cambridge Science Primers.) (Cambridge University Press.) 1s. 6d. net.

The French Revolution. By Thomas Carlyle. (Ward, Lock.) 2s.

England's Neglect of Science. By Prof. John Perry, M.E., D.Sc., F.R.S. (Fisher Unwin.) 2s. 6d. net.

Irritation, or The Muscular Force in Nature and Human Nature. By Richard Steel. (Simpkin, Marshall.) 3s.

Smithsonian Institution. Annual Report of the Board of Regents.

Smithsonian Institution. Report of the U.S. National Museum.

Lunar Theory, Lectures on the. By John Couch Adams, M.A., F.R.S. (Cambridge University Press.)

What is Life? By Frederick Hovenden, F.L.S., F.G.S., F.R.M.S. (Chapman & Hall.) Illustrated. 6s.

Do we Vary in Weight at Different Times in the Day? By W. W. Wagstaffe, B.A., F.R.C.S. (Allard & Son.)

In Nature's Workshop. By Grant Allen. (Newnes.) Ill. 3s. 6d.

Edible British Fungi, An Annotated Catalogue of. By E. W. Swanton. (Huddersfield: The Museum Press.) 2s. 6d. net.

Whence and Whither. By Dr. Paul Carus. (Kegan Paul.) 3s. 6d.

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

The Shrike's 'Larder.'—At the meeting of the British Ornithologists' Club, held in December, 1900, a very interesting discussion took place on the nature and use of the "larders" made by Shrikes. Mr. Hartert and the Rev. H. A. Macpherson believed that the victims were generally impaled for the greater convenience of tearing them in pieces. Mr. Howard Saunders was, however, inclined to think that it was intended as a reserve of food for the young birds. The motive for the "larder" is certainly somewhat obscure. More observation on the point is needed, and those who have opportunities for observing Shrikes would do well to carefully examine the "larders" and endeavour to discover the object of the birds in forming them. These "larders" are rarely of any size, and usually consist of only one or two objects impaled, nor are these necessarily near the nest of the bird, indeed they are usually found away from the nest. It seems doubtful too if the birds have ever been observed to revisit and devour any insect, animal or bird they have impaled.—H. F. W.

Tawny Owl in Ireland (Irish Naturalist, January, 1901, p. 21).—Mr. Robert Patterson records that a Tawny Owl *(Syrnium aluco)* was shot on November 16th, 1900, [illegible] Park, [illegible] and sent to him [illegible] for [illegible]. The bird was [illegible] by a gamekeeper merely for the [illegible] empty glass case. This is the first authentic record [illegible] in Ireland, [illegible] the only question is, was the bird [illegible]? On this point Mr. Patterson says that the plumage showed [illegible] of confinement and that the stomach contained the [illegible] brown rat. The bird was a female.

Pectoral Sandpiper in Ireland.—At the December meeting of the British Ornithological Club, Mr. Howard Saunders [illegible] of Mr. E. Williams, of Dublin, a specimen of the Pectoral Sandpiper *(Heteropygia maculata)*. The bird was a young one, and was shot early in October, 1900, at Belmullet, in co. Mayo. Although this American wader has often occurred in England it has only once before been recorded for Ireland.

On some Migratory and other Birds observed in Southern Shetland in September, 1900. By Wm. Eagle Clarke, F.L.S., and T. G. Laidlaw, M.B.O.U. (*Annals of Scott. Nat. Hist.*, January, 1901, pp. 5–12). This is an interesting and valuable paper because although the Shetlands have been long and thoroughly hunted by egg-collectors, and the breeding birds are consequently well known, present knowledge of the migratory movements of the birds there is extremely scanty. The authors of these notes have added considerably to the little that is known by their short stay in September last. Perhaps the most valuable observations were made in connection with the White Wagtail *(Motacilla alba)*. In his report on the migrations of birds to the last meeting of the British Association (*see* Knowledge, January, 1901, p. 18) Mr. Clarke expressed the opinion that the flocks of Pied Wagtails, said by Saxby to arrive in Unst in the autumn, would be found to be composed of White Wagtails. This surmise proved correct, as a number of White Wagtails were observed by the authors of these notes on the coasts of the southern portion of the main island. The number of other interesting observations of various species recorded in Messrs. Clarke and Laidlaw's paper show that visits by careful observers to the Shetlands during the migration season are sure to prove of value.

Notes on the White Wagtail (Motacilla alba, L.) in the South east of Scotland. By William Evans, F.R.S.E. (*Annals of Scott. Nat. Hist.*, January, 1901, pp. 12–15). These notes are of interest when read in conjunction with Mr. Clarke's British Association paper on the migrations of the White Wagtail.

Notes on the Great Shearwater. By Howard Saunders (*Annals of Scott. Nat. Hist.*, January, 1901, pp. 15–18). Mr. Saunders here gives his authority with full particulars for his statement that the Great Shearwater on alighting "strikes the water with great violence, in a manner quite different from that of a gull, and then dives." This habit of the bird had been noted by Captain J. W. Collins, who had had "exceptional opportunities, extending over many years, for observing the aforesaid Shearwaters upon the fishing banks" off the Eastern coast of North America. Mr. Robert Warren had also noted the habit in some Great Shearwaters which he observed in Ireland in 1893. The breeding place of this bird, by the way, has yet to be discovered.

Fulmar breeding at Cape Wrath. (*Annals of Scott. Nat. Hist.*, January, 1901, p. 50.) Mr. Howard Saunders records that on July 10th, 1900, when passing *close* under Cape Wrath, "several Fulmars came circling round the yacht, and then went to the grassy slopes, on which we could see, with our glasses, birds which we had no doubt were Fulmars, sitting." Mr. Saunders adds, "The Fulmar may well be spreading, for at Soa (St. Kilda), on the 22nd of same month, there seemed to be more than ever."

Nest of Young Starlings in Winter (*Nature*, January 10th, 1901, p. 252). "R. H. F." writes to *Nature* on January 8th, as follows:—"While a friend was walking through his fields near Broxbourne on Sunday afternoon, the 6th inst., he noticed a Starling flying toward an old elm with some food in its bill, and on going up to the tree he found a nest containing young birds. No doubt they are dead by this time, on account of the severe cold, and the difficulty the old birds found in obtaining food for them."

The Origin and Meaning of the Names of British Birds. By A. H. Meiklejohn (*Zoologist*, November, 1900, pp. 511–516). In this paper the author gives some interesting particulars of the derivation of certain popular names of birds. M[illegible] the birds' cries, others refer to their [illegible] distinctive characteristic, but the origin of [illegible] obscure and not satisfactory, while that of some, such as the gull, [illegible], and garganey seems to be quite unknown.

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 PROGRESS OF SEISMOLOGY DURING THE NINETEENTH CENTURY.

By Charles Davison, Sc.D., F.G.S.

Seismology as a science is a product of the latter half of the nineteenth century. Recalling earlier contributions to the subject, that which stands out the most prominently is John Michell's memoir on the cause and phenomena of earthquakes, read before the Royal Society in 1760. It is interesting to notice how Michell anticipates some of the results of later workers. He recognises, for instance, that the slow-period waves are propagated to far greater distances along the surface than the rapid vibrations which form the perceptible shock, and that the velocity of seismic sea-waves increases with the depth of the ocean. He suggests that the position of the epicentre may be determined by observations of the time of occurrence or the direction of the motion. And, though unable, as we still are, to ascertain the depth of the focus, he makes a "random guess" that, in the case of the Lisbon earthquake, it was not less than a mile or a mile and a half and probably not more than three miles. Michell's theoretical views exercised no slight influence on those of his successors. Their chief interest at present is to show how far we have travelled during the nineteenth century.

To describe adequately the progress that has been made would, therefore, be almost the same as to summarise our present knowledge. Nevertheless, there are certain salient features in the history of the subject to which at the beginning of a new century it seems desirable to direct attention.

(1) During the first half of the past century, the contributions were comparatively few in number. Among the most important may be mentioned Darwin's memoir on the volcanic phenomena of South America, and the commencement of the long series of earthquake-catalogues compiled with unfailing industry by Alexis Perrey of Dijon, between the years 1843 and 1874. It would be difficult to investigate the seismic history of any portion of the earth without recourse to one or more of Perrey's valued works.

(2) The foundation of seismology was laid in 1846, when Robert Mallet applied the known laws of wave-motion in solids to the phenomena of earthquakes. Obvious as such an application may seem at the present day, and suggested as it had been by Michell, Thomas Young and others, one cannot estimate Mallet's performance too highly. Though his views on many points are superseded, he threw fresh light on the bearing of facts already known, invented much of the existing terminology, and determined experimentally the velocity of earth-waves in several different rocks. The catalogue of recorded earthquakes prepared with the help of his son, will long be a book of reference to seismologists. But Mallet's greatest achievement was the investigation, by methods due almost entirely to himself, of the earthquake which devastated the kingdom of Naples in December, 1857. No clearer evidence could be furnished of the abiding influence of his labours, than the fact that, out of about 3000 observers of the recent Hereford earthquake, nearly 500 at once recorded the direction of the shock.

(3) To appreciate the importance of the next step one has only to read first the article on "Earthquakes," published in 1877 in the *Encyclopædia Britannica*, and then that on the "Seismometer," which appeared nine years later in the same work. During the interval, seismographs based on scientific principles were invented by Profs. Ewing, Gray and Milne, and their value tested by records of numerous earthquakes in Japan. A modern seismological observatory, indeed, can hardly be regarded as complete if it does not contain either the Gray-Milne or Ewing's three-component seismograph.

While these instruments were expressly made to meet a long-felt want, we are indebted almost to accident for the use of the various forms of the horizontal pendulum which have proved so serviceable in the investigation of distant earthquakes. Hengeller in 1832, Gerard in 1851, Close and Zöllner in 1869, the Darwins in 1880, and von Rebeur-Paschwitz in 1887, all designed the instrument for purposes foreign to seismology, but nevertheless prepared the way for the detailed changes introduced during the last eight years by Milne, Ehlert, Grablovitz, Cancani, and Omori. Good results have also been obtained by means of the long and heavy pendulums favoured by Italian observers.

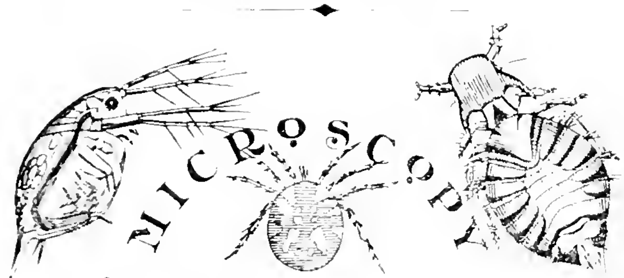
(4) Changes in the amplitude, period and direction of earthquake-vibrations are readily distinguished without instrumental aid; but seismographs have done more than merely add precision to the evidence of our senses. They have rendered manifest features of the earthquake-motion that would otherwise have passed unnoticed. Still more interesting are the revelations of the horizontal pendulum with regard to the pulsations of distant earthquakes. By the disturbance of magnetographs, levels, or lakes, the propagation of surface undulations to immense distances had been known for more than a century. For the fuller knowledge gained during the last twelve years, we are indebted to the late von Rebeur-Paschwitz and those upon whom his mantle has fallen—Prof. Milne, Dr. Agamennone, Mr. Oldham and others. Much still remains to be learnt in this fascinating field of inquiry, but it is no slight feat to have proved that, in an earthquake, two series of elastic waves traverse the body of the earth with velocities of not less than 9 and $5\frac{1}{2}$ kilometres per second respectively; while the slow-period undulations spread over the surface at the rate of 3 kilometres per second, the latter having been traced to distances of more than four-fifths of the earth's circumference. It is an achievement worthy of the last years of the century.

(5) While the more obvious earthquake-phenomena were well-known fifty years ago, closer study has revealed others of equal importance. Statistical inquiries have proved that earthquakes are far more numerous than was formerly supposed, the most modern estimate being that one takes place on an average every half-hour. Harmonic analysis of the seismic records of different countries indicates a distinct periodicity in the occurrence of earthquakes, the maximum of the annual period being as a rule in the local winter and that of the diurnal period at noon. The latest seismic maps, in which epicentres are marked instead of disturbed areas, have led to the conclusion that the most sensitive regions are those in which the mean surface-slope is greatest; while the Japanese earthquake of 1891 and the Indian earthquake of 1897 have shown how rapid may be the rate of terrestrial change.

(6) Following the example of Mallet, detailed histories of important earthquakes have been published by various workers during the last twenty years; particularly of the Ischian, Andalusian, Charlestown, Riviera, Zante, Laibach, Hereford and Indian earth-

quakes Seismological committees or departments have been established in several countries. Thanks to the work of Milne and Omori in Japan, of Saderra and Coronas in the Philippines, of de Rossi, Agamennone, Baratta and Mercalli in Italy, of Eginitis and Papavasiliou in Greece, and many others, some of the finest seismic regions in the world are now secure from neglect. To the labours of von Rebeur-Paschwitz, Milne and Gerland, in founding a seismic survey of the world we may look forward with confidence to obtaining a rich harvest of results.

(7) Concurrently with the growth in our knowledge, the origin of earthquakes has become more clearly understood. There are many shocks, marked as a rule by small disturbed areas and abnormal intensity near the centre, which we can hardly err in attributing to volcanic action in some cases, and in others to local disturbances partly natural and partly artificial. But all severe earthquakes and the majority of slight ones we seem to be equally justified in connecting with the formation of faults. In regarding earthquakes as the passing effects of the gradual but intermittent growth of faults, we are relying on a source of energy competent to produce the strongest as well as the weakest shock. At the same time, we are investing earthquakes with a significance which they certainly did not possess for us at the beginning of the nineteenth century, as indices of the site and epoch of the changes that are now taking place in the earth's crust.



Conducted by M. I. Cross.

Photo-Micrography.—One of the great difficulties experienced by novices in photo-micrography is in the attempt to get an evenly illuminated disc with a clear sharp edge. Various devices have been tried to accomplish this, including masks placed immediately in front of the plate during exposure, and cutting down the disc by means of a mask when printing from the negative, but these are really, so far as the disc is concerned, attempts to obliterate an original error of manipulation. The necessity for masking off a portion of the field during printing so as to get only the portion that is in focus in the centre is not now under consideration.

It is proposed to give directions which, if attended to, will ensure a clear, evenly illuminated disc with a sharp edge.

In the first place suitable apparatus is requisite, and in addition to the camera, microscope and objectives, the following should be included: illuminant—preferably zirconium or lime light—bull's-eye condenser *with iris diaphragm* immediately in front of it; substage condenser; projection eyepiece; and a piece of glazed cardboard about 6 inches square mounted on a wooden support so that it may be central with the optic axis of the microscope; a darkened room.

The microscopic object should be placed on the stage and the objective and substage condenser adjusted exactly as for a visual examination. The microscope is then set in position on the camera base. The cardboard should now be set up at a distance of about 6 inches from the eyepiece.

Light up, centre the jet or source of illumination as nearly as can be roughly done to the bull's-eye, then centre the bull's-eye to the microscope. This is done in the following manner:—

It will be observed that a faintly illuminated disc will appear upon the cardboard when light is passed through the condensers. The iris diaphragm attached to the bull's-eye must now be treated as the source of light, and the position of the bull's-eye altered until the centre of this iris diaphragm corresponds with the centre of the microscope. In order to do this exactly, the iris of the bull's-eye should be almost closed, and if the focus of the substage condenser be altered slightly the outline of this iris diaphragm will appear sharply upon the card. It should, after accurate centering, be opened to just such an extent as the circumstances allow. Next alter the adjusting collar carrying the eye lens of the projection eyepiece so that a sharply defined edge is given to the disc.

It will now be necessary to centre the light to the bull's-eye, which together with its backward or forward position can be checked by allowing its image to fall upon a screen of card set at the back of the substage condenser, in the manner recommended in the various text-books.

If all these adjustments are made with care, and the iris of the bull's eye opened to the proper extent, an evenly illuminated disc should result, and nothing remains but to view and finally focus the image upon the focussing screen and take the photograph, using of course such coloured glasses, etc., as the objects may necessitate.

A New Heating Stage.—Mr. Leonard P. Wilson, F.C.S., sends us the following description of a new heating stage of his own design. During the course of some recent crystallographic investigations, it was considered necessary to examine, microscopically, a number of substances at known constant temperatures. In order to do this, a heating stage was essential, but none of those in general use appeared to fulfil the requirements, the fault lying chiefly in the fact that the slide, being heated only from below, was cooled irregularly by currents of air. A stage was therefore designed in which the temperature of the slide could be accurately known, and could be easily controlled. The construction of this stage was such that the heating medium, generally water, flowed both above and below the slide, thus heating it uniformly, while air currents could only enter by the narrow aperture through which the slide and its carrier were introduced into the stage, the circular apertures

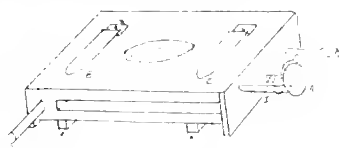


Fig. 1

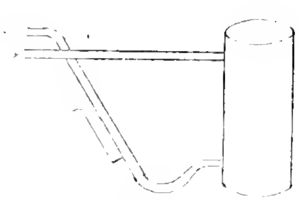


Fig. 3

Fig. 2

in the optic axis of the microscope being protected as hereafter described. As shown in Fig. 1, the stage is in the form of a double box, forming a water jacket to the slide and its carrier. Water of the required temperature is passed in at A, and flows out at B, the temperature being taken by means of a thermometer inserted into the tube C, round which the water passes in the middle of its course. The heating stage is fastened to the mechanical stage by means of the screw D. When using a high power, the objective passes into the upper aperture of the stage, and is below the level of its upper surface, and in order that the stage may move freely in all directions in conjunction with the movements of the mechanical stage, it is necessary that this tubular aperture be greater in diameter than the objective. To prevent the intrusion of cold air which might take place owing to this difference in diameter, a vulcanite plate, having an aperture which the objective just fits, slides on the surface of the stage, under the clips E, E. In a manner similar to the objective, the condenser passes up into the lower portion of the stage; space for the vulcanite plate in this case being made by the introduction of two bars X, X, across the lower surface of the stage, which is thereby raised above the mechanical stage. The slide carrier, as shown in Fig. 2, consists of a brass plate, having a circular aperture through it, and having fixed to it two springs, S, S. By means of these springs the slide is held in position on the carrier, and the carrier is also held in position between the upper and lower plates of the stage. The slide can be roughly adjusted by means of the carrier, fine adjustment being made with the mechanical stage. The heating apparatus is as in Fig. 3, and by slightly raising or lowering the flame, the temperature can be regulated and kept constant within half a degree Centigrade.

LIGHT FILTERS.—A few years ago it was pointed out by Mr. Nelson that the use of suitable light filters improved the working of objectives in a marvellous manner, that if the filter employed was practically of the same colour as the ray for which the spherical aberration of the objective was best corrected, a good modern achromatic lens would perform equally as well as an expensive apochromat.

The most practical and successful of light filters at present in use consists of a saturated solution of acetate of copper. This should be placed in a trough and intervene between the illuminant and the substage condenser.

The internal thickness of this trough should not be less than $\frac{3}{8}$ inch; $\frac{5}{16}$ inch barely causes the absorption of the red in the spectrum, $\frac{3}{8}$ inch exactly does it with an oil lamp having a $\frac{1}{2}$ inch wick. If a more brilliant illuminant be used, a greater depth of trough can without disadvantage be employed. We recommend a trial of this medium to all workers who would improve the definition of their object glasses.

Another advantage of a light filter of this description is that the full cone of the substage condenser can be used without the brilliance of illumination being so great as to cause the observer discomfort.

NOTES AND QUERIES.—*Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to* M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

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

COMETARY DISCOVERIES DURING THE NINETEENTH CENTURY.—The extraordinary progress effected in all departments of astronomy during the past century is well exemplified in that branch relating to comets, for there were nearly four times as many new comets found between 1801 and 1900 as between 1701 and 1800, the relative numbers being 235 and 62. The century just concluded has, in fact, furnished us with many important items respecting these mysterious bodies. In 1800 only one periodical comet was known, viz., that of Halley's. At the present time we are acquainted with a large number, which are grouped into families, the most numerous and best known being those with aphelia, just outside the orbit of Jupiter. During the century just opened the field of cometary discovery will no doubt continue a very productive one, but it is not likely that the figures will show a great increase as compared with the last century. The rate of these discoveries has not exhibited any marked rise since the year 1840, and it is difficult to see how it can be much accelerated unless a more expeditious means of seeking for these bodies is adopted, or many more observers than hitherto apply themselves to the work.

COMET 1891 IV. (DE VICO E. SWIFT).—It is expected that this comet will arrive at perihelion on February 13th, but it will then be overpowered by the rays of the sun.

BRORSEN'S COMET.—This comet is moving rapidly to N.W., and ought to be well visible in February. No announcement of its re-discovery has, however, yet been made. In view of the fact that the comet has eluded detection at several previous returns its existence is a little questionable, and there appears some ground for the inference that it has, like the comet of Biela, suffered disintegration. It will, however, be diligently sought for by means of some of the large telescopes available for this kind of work, and we may shortly expect to hear of its re-detection if it revolves in the same orbit as formerly, and still visibly exists under the form of a comet.

NEW COMET.—A new comet is announced as having been discovered by M. Giacobini, at Nice on December 20th. Its approximate position was R.A. 338°, Dec. S. 22°. On December 24th, 8h. 43m., G.M.T., its place was R.A. 344$\frac{1}{2}$°, Dec. S. 22°, so the object is moving about 1$\frac{1}{2}$° per day to the E.S.E. During the last few years M. Giacobini's discoveries of comets have been rather numerous and important, and in recognition of his successful labours in this field the French Academy of Sciences has recently awarded him the Lalande Prize.

AUTUMN METEORS.—In October and November Prof. A. S. Herschel, of Slough, observed 120 meteors, and determined the positions of the chief radiants as follows:—57° + 9° (11 meteors), 57° + 18° (11), 56° + 28° (8), 70° + 35° (8), 80° + 18° (6), 75° + 13° (4), 44° + 24° (9), 44° + 12° (10). The first two radiants represent well-defined showers of Taurids.

THE GEMINIDS.—On December 13th the sky was beautifully clear, and a number of meteors were observed at various places. At Slough Prof. Herschel watched from 11$\frac{3}{4}$h. to 13$\frac{1}{4}$h. and recorded about 20 meteors, including two fine ones, as follows:—

11h. 58m.—Magnitude twice as bright as Venus. Path of about 35 degrees from ζ Persei to halfway between β and γ Arietis. Probable radiant 167° + 5°.

12h. 26m.—Magnitude equal to Jupiter. Path from 1° N. of λ Orionis to 1° S. of γ Tauri. Moved over 30° in $\frac{3}{4}$ second. Probable radiant 121° − 1°.

About one-third of the meteors seen were Geminids with the usual short tracks and quick motions.

Mr. T. H. Astbury, of Wallingford, watched the sky on December 13th between 8h. 10m. and 9h. o'clock, and registered 14 meteors, of which 12 were Geminids, the centres of radiation being 109° + 35° and 113° + 32°. A later observation from 9h. 50m. to 10h. 30m. furnished three additional Geminids, but the shower appeared to have greatly declined as compared with its unusual activity earlier in the evening.

Mr. C. L. Brook, at Meltham, near Huddersfield, observing for 2$\frac{3}{4}$ hours on December 11th, between 9h. and 12h., saw 19 meteors, of which 11 were Geminids. On December 12th he watched 3h. 25m. of the interval between 8h. and 12$\frac{1}{4}$h., and saw 25 meteors, including 17 Geminids. Between 10h. 51m. and 11h. 35m. no less than 13 Geminids were recorded.

On December 13th, 10h. 18$\frac{1}{2}$m., a rather fine δ Geminid, brighter than a first magnitude star, was observed by Mr. A. King, of Leicester, and Mr. T. H. Astbury at Wallingford. The meteor fell from a height of 59 to 44 miles, and its course lay from nearly over Hertford to Luton. Length of path 24 miles, and earth point 8 miles west of Banbury.

FIREBALLS.—Several of these striking objects have been recently observed from various parts of the country. The dates and times were as under:—November 27th, 11h. 10m.; December 1st, 4h. 12m. and 12h.; December 10th, 3h. 55m. a.m.; December 16th, 7h. 35m. a.m.; December 17th, 5h. 55m p.m. Mr. G. Herbert Price, of Brixton Hill, S.W., also reports a bright meteor seen on December 13th, 9h. 20m., traversing a path from Gemini to the region of Aries. A rather sensational incident occurred on Saturday night, December 22nd, according to the *Pall Mall Gazette*, which states that "a large meteorite fell at Great Parndor, Essex. Frederick Armour, a local postman, who was passing the field in which it fell, states that he was blinded and stunned by the brilliant flash of light. He was found unconscious in the roadway."

FIREBALL IN SUNSHINE.—On January 6th, 1901, at 0h. 52m. p.m., a large meteor was observed from various places in Scotland and the extreme N. of England. As seen from Glasgow the object is described as a large ball of fire with a long streaming tail. The meteor disappeared in the N.W. quarter at rather a low altitude, and it was directed from the E.N.E., so that the probable radiant was in the region of Perseus or Aries. Mr. W. H. S. Monck has kindly sent me several newspaper accounts of the fireball, but they are wanting in some of the definite particulars necessary for the computation of the real path. There was a brilliant meteor seen in sunshine on January 9th, 1900 (*see* KNOWLEDGE, February, 1900, p. 47), but this object must have emanated from a different stream to that which furnished the more recent meteor. It is astonishing how many large meteors have been observed even in the presence of the sun, and it proves that they are unusually prevalent in the day-time. Unfortunately, however, they are seldom well observed as regards their position and direction of flight.

THE FACE OF THE SKY FOR FEBRUARY.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 7.42 A.M., and sets at 4.46 P.M.; on the 28th he rises at 6.51 A.M. and sets at 5.35 P.M. Few sunspots are to be expected. The Zodiacal Light may be looked for in the west after sunset.

THE MOON.—The moon will be full on the 3rd at 3.30 P.M., will enter last quarter on the 11th at 6.12 P.M., will be new on the 19th at 2.45 A.M., and will enter first quarter on the 25th at 6.38 P.M. The following are among the more interesting occultations which occur at convenient times during the month.

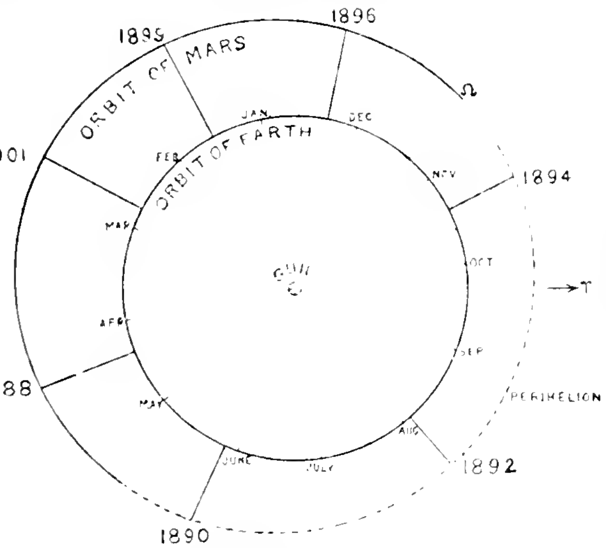
Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
									d. h.
Feb. 1	D.M. +17°179	6.6	6.32 P.M.	14[illegible]	18[illegible]	7.18	[illegible]	[illegible]	12 4
,, 21	51 Piscium	5.7	6.54 P.M.	76	[illegible]	[illegible]	21[illegible]	2[illegible]	2 17
,, 22	ε Piscium	6.6	10.20 P.M.	97	59	11.7	2[illegible]	2[illegible]	3 20

Star below horizon.

The Planets.—Mercury is an evening star throughout the month, reaching an easterly elongation of 18° 6′ on the 19th. About this time he will be well placed for observation, as he remains above the horizon nearly an hour and three quarters after the sun has set. The planet will be found a little south of west. On the evening of the 20th the planet will be a few degrees to the south-west of the moon. There are no bright stars near the planet.

Venus is a morning star throughout the month, but not well placed for observation. On the 11th, the illuminated part of the disc is 0.949, and the planet does not rise until nearly 7 A.M.

Mars arrives at opposition on the morning of the 22nd, and may be observed throughout the greater part of the night. He remains in Leo, rising shortly after 7 P.M. on the 1st, and before 4.30 P.M. on the 28th. As will be seen from the appended diagram the opposition is by no means one of the most favourable, the



Oppositions of Mars.

distance of the planet from the earth being close upon 60 millions of miles, as compared with 35 millions at the most favourable oppositions. The apparent diameter of the planet at the time of this opposition is 13″.8. It is winter in the southern hemisphere of Mars, and the north pole is turned towards the earth.

Jupiter, Saturn, and Uranus are morning stars, but not very well placed for observation. On the 14th they rise respectively at 4.54 A.M., 5.21 A.M., and 3.49 A.M. Jupiter and Saturn are in Sagittarius, Uranus in the most southerly part of Ophiuchus.

Neptune remains in the most easterly part of Taurus, and during the month traverses a very short westerly path nearly midway between 132 Tauri and χ Orionis.

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 [illegible] of east; Cancer and Hydra in the south[illegible]; [illegible] and Auriga nearly overhead; Canis Minor and [illegible] near the meridian; Orion a little west of [illegible] in the south-west; Aries and Perseus [illegible]; and Andromeda and Cassiopeia towards the [illegible].

A minimum of Algol will occur on the 15th at 11.21 P.M., and another on the 18th at 8.10 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 January Problems.

(W. Geary.)

No. 1.

1. Kt to R5, and mates next move.

No. 2.

Key move—1. Q to QKt3.

If 1. . . . Kt or RP moves,	2. Kt to Kt3ch.
1. . . . K or KtP moves,	2. Kt to K6.

Kt to Q3 and Kt to KKt2, given by several correspondents as keys to No. 1, fail on account of the reply 1. . . . KtP × R.

Correct Solutions of both problems received from J. Baddeley, H. Le Jeune, B. Harley, G. Groom, F. J. Lea, G. A. Forde (Capt.), S. G. Luckcock, W. de P. Crousaz, W. H. S. M., J. T. Blakemore, N. K. Dutt, Enderby, F. Dennis, C. L. Massey, Eugene Henry, A. J. Head, G. W., J. Sowden, G. W. Middleton, T. H. Billington, C. Johnston, H. Boyes, A.C. Challenger, E. Hunt, Vivien H. Macmeikan, W. E. P., A. Dod, W. Jay, A. E. Whitehouse, W. Geary, W. Boyd, C. F. P., S. W. Billings, N. B., W. B. Alldritt, W. F. P., T. Earl, J. E. Broadbent, C. Child, C. S. Hudson.

Of No. 1 only from J. M. K., J. A. Nicholson, W. Nash, C. C. Pennington, J. Bernard Corp.

Of No. 2 only from A. H. Machell Cox, L. J. R. Cripps, J. T. Stockwell, H. L. Gillespie, H. S. Brandreth, J. W. Meyjes, Alpha, W. Smith, F. Stokoe, J. Neville.

P. A. Cobbold.—Solution of No. 2 (December) correct. No. 1, however, cannot be solved by 1. B to R1, on account of 1. . . . B to Q7 (!), when 2. R to Q4 is not mate. So also, if 1. B × KP, B to B5. Both are good "tries." Of course it would be impossible for you to post in time from Canada.

G. A. Forde.—Thanks for your suggestion. I think, however, that to start numbering the problems continuously from the present time would convey a false impression of the antiquity of this page. In the case of a monthly magazine, there is no difficulty in referring to any problem, *e.g.*, as "No. 2 of June, 1897," or "No. 1 of May, 1926," etc.

A. W. Tyer, J. M. K., and others.—1. Q to QB3 is answered by P to Kt6; and, if then 2. Kt to K6, K to Q1.

F. Dennis.—Besides giving point to the problem, the KB is necessary in Mr. Allen's December problem. At any rate the composer had to stop any immediate check at K7 with the Rook, and if he uses a Black Pawn for that purpose, it must be pinned by a Bishop in view of

K × Kt. No doubt the problem could have been constructed without it.

J. M. K.—I should say that there would be no objection to it.

H. L. Gillespie.—If 1. B × P, B × R, or KP × P are valid defences.

J. W. Meyjes.—If 1. Kt × P, P × R; or if 1. Kt to R3 the same applies. I regret that you should score – 1 according to the rules.

G. W.—Certainly; postcards are preferred.

Alpha.—I agree that "key only" is a very liberal condition in the case of three-movers. It saves, however, a good deal of trouble, from clerical errors and otherwise, and gives comparative novices a better chance of keeping up with expert solvers. In the end it would be safe to say that a solver not capable of seeing the correct second moves would have little chance of winning a solution tournament extending over a year.

W. H. Gundry.—Thanks for the problem, which appears below.

J. Sowden.—Yes; postcards are preferred.

G. W. Middleton.—No points are given for proving a position to be impossible in actual play.

C. C. Pennington and *J. Bernard Corp.*—If 1. K to K6, Kt to B3.

J. W. Hobbs.—1. K to B6 will not solve No. 2.

F. Stokoe.—1. Kt to R3 is answered by P × R. It is strange that so many solvers have overlooked this defence.

W. E. P.—A second solution is the same as a cook; but not more than three points can be scored for a two-mover, or more than four points for a three-mover, even if a problem has a dozen keys.

J. Neville.—Many thanks, but I fear there is no space for any matter concerning a single county only.

C. F. P.—It is necessary to provide for the event of a problem having no solution. The best composers occasionally overlook some obscure defence. To avoid the waste of time which you deprecate, no three-move problem known to have no solution will be printed.

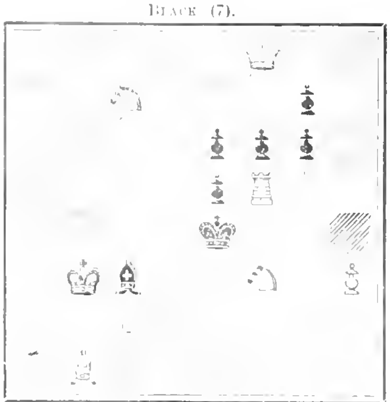
C. S. Hudson.—Much regret the unfortunate lateness, but fear that the rule leaves no option.

PROBLEMS.

No. 1.

By W. H. Gundry.

Black (7).



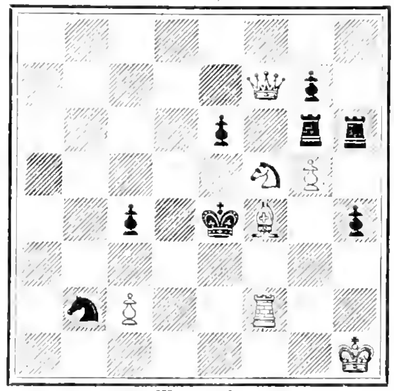
White (10).

White mates in two moves.

No. 2.

By B. G. Laws.

Black (8).



White (7).

White mates in three moves.

Owing to the large number of solvers this month—fifty-eight sent in solutions—it has been decided to give, as equal third and fourth prizes, Knowledge for six months. It is hoped that those who have temporarily lost a point or two will not immediately withdraw from the contest. Some of the problems due to appear will give them excellent chances of recovery, being of a nature to deceive probably a good many of those who now head the score.

CHESS INTELLIGENCE.

There were only four entries this year for the Craigside Challenge Cup Competition. Mr. A. Burn proved the winner with a score of 3 wins, 3 draws, and no losses, one point of Mr. H. E. Atkins who scored $3\frac{1}{2}$, losing both games to Mr. Burn. Mr. W. H. Gunston was third with $2\frac{1}{2}$, and Mr. G. E. H. Bellingham fourth and last with 1. In the other principal tournament Mr. A. Dod was first, and Mr. C. H. Sherrard second. Mr. Billington, one of our solvers this month, won the second-class event. Mr. Dod, we are glad to see, has also entered for the present competition. It is almost safe to predict that anyone who gets ahead of these two will come very near winning.

The entries for the International Tournament at Monte Carlo include, so far as is known at present, the names of Messrs. Blackburne, Cohn, Lipschütz, Mason, Marco, Mieses, Schlechter, Tchigorin and Winawer, a strong, though not quite a representative list in the absence of Lasker, Maroczy, Janowski, Pillsbury and Burn.

The very short tournament at Simpson's Divan was won by R. Teichmann; the remaining competitors, Messrs. Müller, Lee, Van Vliet, and Mortimer, coming out in the order mentioned.

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

The yearly bound volumes of Knowledge, cloth gilt, 8s. 6d., post free.

Binding Cases, 1s. 6d. each; post free, 1s. 9d.

Subscribers' numbers bound (including case and Index), 2s. 6d. each volume.

Index of Articles and Illustrations for 1891, 1892, 1894, 1895, 1896, 1897, 1898, 1899, and 1900 can be supplied for 3d. each.

All remittances should be made payable to the Publisher of "Knowledge."

"Knowledge" Annual Subscription, throughout the world, 7s. 6d., post free.

Communications for the Editors and Books for Review should be addressed Editors, "Knowledge," 326, High Holborn, London, W.C.

KNOWLEDGE

AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

VOL. XXIV.] LONDON: MARCH 1, 1901. [No. 185.

CONTENTS.

EXPLORING THE THUNDER CLOUD.

By the Rev. JOHN M. BACON, F.R.A.S.

PERCHANCE you have lain awake in a draughty seaside lodging when the wind has been rising and have heard a door in the house banging at intervals at the sport of the wind. Time after time it opens a little way and remains ajar, perhaps for quite a considerable period, when it abruptly "blows to" again. And this provoking performance goes on indefinitely with persistent monotony. The puffs of wind that are responsible for this annoyance, if in an incipient state, will often be found to recur with almost rhythmic regularity. The same phenomenon is noticeable enough out of doors on most days when wind is stirring, but being then less obtrusive generally goes unheeded.

Sometimes, however, the gusts will come on with such impetuous force—like very explosions—that they cannot be ignored. The [illegible] [illegible] gun and the sailor by sk[illegible] also [illegible] [illegible]ful count of them. On a stormy day, during [illegible] [illegible] few final minutes when a balloon is being [illegible] and adjusted for the start, the heavy gusts that [illegible] past have to be promptly met, and it is fortunate [illegible] their onslaughts are often sufficiently well timed [illegible] of their being fully expected.

It is no uncommon event for a thunder storm to [illegible] with one of these wilder squalls, and in this case it is well known that the motion of the storm as a whole is markedly slower than the average speed of the wind—very commonly a shallow one—which bears it. On another occasion the cloud may be found riding some upper and contrary current, and under these circumstances gives apparent justification for the popular saying that "a thunder storm will come up against the wind." Once this last summer I chanced to be aloft when a disturbance of this nature was brewing, and was able to note the gathering of the storm from the somewhat uncommon point of vantage furnished by a free balloon.

July 27 last was, at least for Newbury and twenty miles round, a day that was characterised by such well marked regular gusts as I have referred to. It also became a typical day of summer storms, and it should be mentioned that the nature of the weather indicated the passage of a well pronounced "secondary," such as is so commonly associated with thunder storms. It is frequently asserted that a characteristic feature of such storms is that the lower sweep of wind which circles over the surface of the ground is very shallow, while at only a moderate height overhead there may be a wholly different drift. This at any rate was the state of affairs as betrayed by the behaviour of the storm I am able to describe.

Before leaving the earth I had entered certain memoranda in my note book, one of which runs thus: "All through the day weather cocks have been pointing E., while clouds estimated at 2,000 ft. altitude have been scurrying in an opposite direction. The first thunder storm broke over the town at 1 p.m. It was short but severe, the thunder as heard in the main street being as deafening and prolonged as any that I can recall." Another note is to the effect that the oncoming storm approached from due south, and as it burst on our enclosure set the balloon, already filled, spinning in a direction contrary to that of clock hands. Several pilot balloons, which were sent up through the afternoon, and which became invisible before they had reached any great height, went sometimes S.W. and sometimes W., and seemed to hesitate between these two directions.

At 5.15 what was apparently the clearing shower had passed over, and the sky was seen everywhere cloudless up to a great height, the wind on the ground dropping shortly to almost a dead calm. Had any cloudlet been left in evidence at a few hundred feet overhead, or had we at this juncture sent up another pilot, the ascent might have been postponed, or at least the more experienced among us would have altered their opinion about the "clearing shower."

At 5.45 we cast off and leisurely took a N.W. direction heading for Swindon, and thus proceeded till we had covered rather more than a mile [illegible] and risen about 700 ft. in height. At th[illegible] we abruptly came under the influence of a well [illegible] current which diverted our course to that of the Kennet Valley, trending sensibly due west, and [illegible] closely followed up the line of this valley for many miles.

In scarcely more than twenty minutes from the start a sudden and surprising change took place in our circumstances. Our environment, which had appeared absolutely calm and clear, began changing with the rapidity of a transformation scene. Below us the few hundred feet that separated us from earth began filling in with a blue haze, quite transparent, but growing palpably filmier, while ahead, as also right and left, the horizon at the level of our eye and higher opposed a dense fog barrier of an ashen hue. Overhead of course the sky view was entirely hidden by the huge silken globe. At this period of time we were being swept along on our course, which remained sensibly unaltered in direction, at a speed which we were subsequently able to fix at approximately forty miles an hour.

To ourselves the full significance of these circumstances was not immediately apparent, but the onlookers at our point of departure—the town gas-works, now some five miles in our wake—clearly detected the approach of a heavy thunder pack, and as they reasonably asserted coming against the wind. It towered above the balloon, now seen projected plainly against its face. It came on rapidly and assumed formidable proportions, and there was then the following state of things. The balloon flying due west at the high speed just recorded and, at apparently no great distance overhead, the thunder cloud progressing at a moderate velocity, not accurately determined but due east or directly opposed to the surface current.

And now with a whistle a blinding sheet of hail attacked the aeronauts, stinging their faces so sharply as to give the idea that the stones were falling from a great height, and immediately afterwards from all sides and close around flashes of lightning shot out with remarkable frequency and vividness. We were, in fact, fairly embosomed in the thunder cloud. Other and near observers narrowly watched the phases of phenomena now in progress. These were the countrymen who became interested spectators, and who presently came to our assistance. They seemed to have imagined that the balloon must be infallibly struck, inasmuch as it appeared to them completely encircled with lightning. It was indeed the worst storm the country side had known for many years. At Devizes, only a few miles ahead, it lasted for five hours continuously; a little way on our right a house was struck and burnt to the ground, and on our left a couple of soldiers were killed on Salisbury Plain.

I would call attention to the fact that though the storm progressed, it also appeared to lag behind the wind that bore it along. I would also lay stress on the further fact that it did not seem to advance against us as a whole, but rather gathered about us, forming itself out of what a few moments before had appeared mere empty and transparent air. Very probably this gathering storm curtain was largely due to the sudden chill which now was very manifest in the air, and which obviously had its origin from above. In the depth below us there was no evidence of any special disturbance, and a parachute dropped from the car about this period floated to the earth steadily and with no divergence.

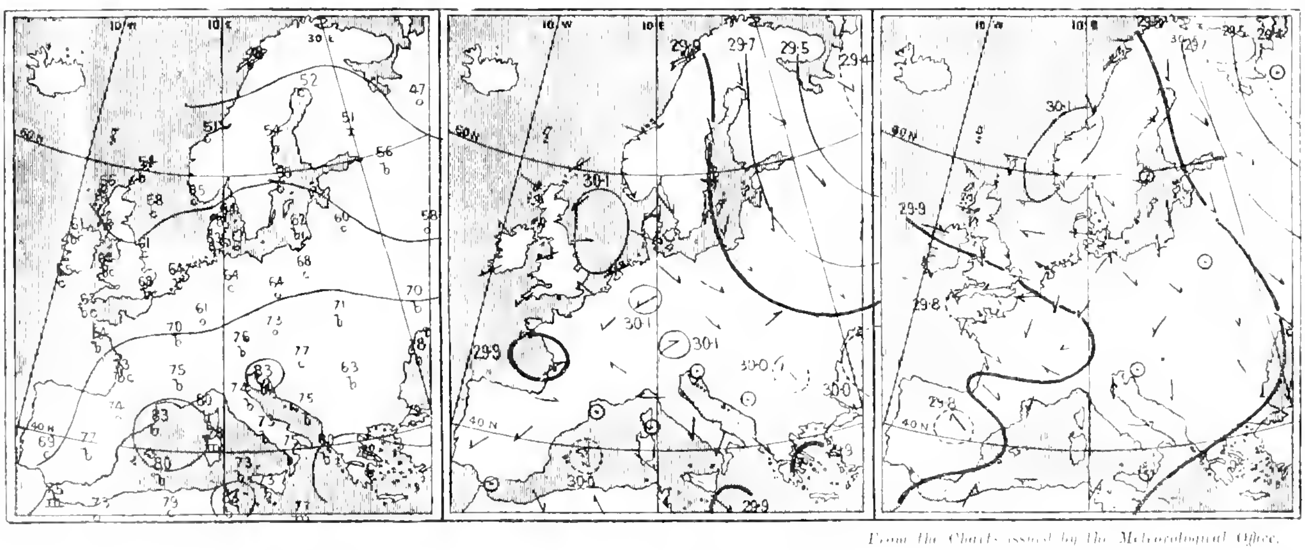
All this may be taken to lend confirmation to the theory that associates thunder storms with sudden and considerable alterations of temperature in contiguous masses of air.

It is worthy of mention that 73 years before an ascent had been made from the same spot at Newbury by the famous Charles Green, under circumstances which it will be seen resembled in many particulars those of the present occasion. The day was marked by squalls and the ascent postponed until the evening, when the storms gave signs of having cleared off. This appearance, however, was illusory, and the aeronauts presently encountered a thunder storm, the balloon, which had attained an altitude of two miles, being above instead of below the storm cloud. Mr. Green thus describes the situation: "At this altitude we perceived two immense bodies of clouds operated on by contrary currents of air until at length they became united, and at that moment my ears were assailed with the most awful and long continued peal of thunder I ever heard. These clouds were a full mile below us."

This reverberation of the thunder is worthy of a little consideration. It is to me intelligible enough when it is remembered that the source of sound lay between the balloon and the earth, in which case it only resembled the artificial thunder which I have often evoked by

Friday, 27th July.

Temperature and Weather. 8 a.m. — Barometer and Wind. 8 a.m. — 6 p.m.



From the Charts issued by the Meteorological Office.

explosions of gun cotton. In our own experience just cited, however, the lightning flashes which appeared to course between cloud and cloud rather than between cloud and earth were like typical mountain storms followed only by a single short report, and in this resembled phenomena twice observed by Mr. Wise in America. This observant aeronant on two separate occasions speaks of thunder as "rattling like small arms without any of the rolling reverberations that are heard below." But another significant observation was made by Mr. Wise in both his experiences just referred to. "The thunder pack itself developed uprising cloud columns whose motion resembled that of ebullition in a vast cauldron from whence electric flashes were discharged." With almost the same language he describes the effect presented to him on each occasion when he approached from aloft the neighbourhood of a thunder storm; and Mr. Green in his Newbury ascent already alluded to, uses words that are hardly dissimilar. "I observed," he says, "among other phenomena at every discharge of thunder all the detached pillars of cloud within the distance of a mile round became attracted and appeared to concentrate their force towards the first body of clouds, leaving the atmosphere clear and calm beneath and around us." Neither of the above bygone aeronauts describe to my knowledge any occasion when they have actually found themselves in the heart of a thunderstorm, and in our own case, had there been but fair warning, I think there would have been but little difficulty in avoiding the storm by simply rising above it; but, as I have already sufficiently explained, we were practically without warning from the peculiar manner in which from our restricted point of view the thunder cloud seemed to develop about us out of thin air.

I do not imagine that the smart impact of the hail stones necessarily proved that their origin was far overhead. It is my impression that the hail was being forcibly swept down upon us by a violent downrush of icy air, and as we were counteracting the descent of the balloon by a discharge of ballast our own motion would not reduce the pelting of the storm.

It needs no pointing out that hail is chiefly a phenomenon of the warmer hours of a summer day suggesting that warm moist currents are answerable for its formation, and in this view we may fairly regard the thunder cloud itself as its cradle, and this very frequently at no higher altitude than a mile above the surface of the ground.

The tendency of hail to form with exceptional frequency and severity over certain areas is a local phenomenon which has perhaps hardly met with the attention it deserves, but no facts are more striking or better established. In KNOWLEDGE some years ago it was stated that "within a radius of 12 miles round Somersham Railway Station (Huntingdonshire) hailstorms are so frequent and destructive that all the insurance companies charge double the ordinary rates per acre for crops growing within that district."

The general meteorological conditions prevailing at the time of the storm above described are given in the accompanying charts.

THE INSECTS OF THE SEA. II.

By GEO. H. CARPENTER, B.SC.(LOND.), *Assistant in the Museum of Science and Art, Dublin.*

SPRING TAILS.

"WHY the Collembola should be neglected," wrote Dr Sharp* in 1895, "when the [illegible] attract so much attention, is as inexplicable as [illegible] other fashions are." During the last few years [illegible] Spring-tails or Collembola have been receiving [illegible] of attention from naturalists, and it [illegible] that the entomological fashion to which Dr Sharp [illegible] destined to show its likeness to other fashions [illegible] a marked change in the near future. The [illegible] by the sea-shore at least ought not to neglect the Spring-tails. Smaller and less conspicuous than the Bristle-tail, *Machilis maritima* (described in KNOWLEDGE for January), the marine Spring-tails may be, but they are fairly numerous in species, and some of them are more perfectly adapted than Machilis for a marine life.

Spring-tails resemble Bristle-tails in being entirely without a trace of wings, and have often been united with them in the order Thysanura (to which it has lately been suggested to restore the Linnean title Aptera). But the divergence between the two groups is in many respects so striking that Lord Avebury's separation† of the Spring-tails as a special order, to which he applied the name Collembola, seems to be fully justified. The name (Κόλλα, *glue*, and ἐμβολή, *a throwing in*) refers to the supposed function of the "ventral tube"—a very characteristic organ of these insects, situated beneath the first segment of the hind body (Fig. 1, *v. t.*); it shelters two protrusible processes which may help the insects to cling to smooth surfaces, or may possibly, like the abdominal sacs of Machilis, serve as breathing organs. This tube is unknown among the Bristle-tails, and there are other and more conspicuous differences between the two groups. The hind-body of a Spring-tail has never more than six evident segments, and long "tail-bristles" like those of the tenth abdominal segment in the Thysanura are never present. The feelers, always with very numerous segments among the Bristle-tails, have never more than six distinct segments among the Spring-tails.

The reduction in the number of abdominal segments from ten to six marks the Spring-tails as a less primitive group than the Bristle-tails. And their specialization is further shown by the possession of that very remarkable organ the "spring"—which gives them their English name. The spring (Fig. 1, *s*), which may be borne beneath either of the fourth or fifth abdominal segment, roughly resembles a two-pronged fork, consisting of a single basal piece—the "handle" (*manubrium*), to which are attached two long, flexible tapering "teeth" (*dentes*); at the end of each tooth is articulated a little "point" or tip (*mucro*) which is not always sharp. It is likely that this spring has been formed by the fusion of a pair of abdominal limbs. It may be tucked beneath the body pointing forwards, as the insect runs along; when it is released and straightened out so that the tip points backwards, the Spring-tail leaps into the air. Let the reader lift a stone under which a colony of Spring-tails are sheltering, and he will have full demonstration of their leaping powers. (See Fig. 1.)

There is a family of Spring-tails, the Sminthuridæ, having, however, no marine representatives, with compact globular hind-body; these insects breathe by means of a set of air-tubes opening by paired air-holes on the head—an altogether exceptional position. But most Spring-tails have no air-tubes at all; they breathe entirely through the skin. Adaptation to an aquatic life is

* "The Cambridge Natural History," Vol. V., p. 190.

† Sir John Lubbock. "Monograph of the Collembola and Thysanura." London (*Ray Society*), 1873.

therefore, easy to them. Many species are found on the marshy shores or on the surface of the waters of lakes and ponds, and quite a fair number will reward the researches of the seaside entomologist.

Several species of the genus Isotoma, for example, may be found jumping about among the cast-up seaweed at highwater mark. Some of these are of interest since they occur indifferently in inland and sea-shore localities. Isotoma belongs to the Entomobryidæ—the most typical family of the Spring-tails—characterised by a well-developed spring (borne on the fifth abdominal segment), a very small front fore-body segment (prothorax), and a clearly segmented hind-body. The species of Isotoma are not scaly as many spring-tails are, but are clothed with numerous hairs, sometimes also with bristles. The hind-body segments are equal in length or almost so. *Isotoma palustris* (Muller) is one of our commonest Spring-tails, occurring among herbage in marshy places, and by the edges of ponds. But this species may also be found among seaweed, and a dark, violet-brown variety, haunting the coasts of the Baltic, has been named *balthica* by Drs. Reuter and Schött.‡ This particular variety, however, is known to occur in Scotland by inland bogs. Such indifference on the part of the same insect to marshy or sea-shore surroundings is highly instructive, for it shows us a Spring-tail of the land in the act of establishing itself along the tidal margin. *Isotoma littoralis*, described by Prof. Moniez,§ from the French coasts of the Channel, is probably a form of this species. "It is very common," he writes, "under the fucus which clothes the rocks uncovered at each tide. It runs very quickly beneath this shelter, leaps with the greatest ease, and takes refuge readily among the fronds of seaweeds or the shells of barnacles, when it is disturbed."

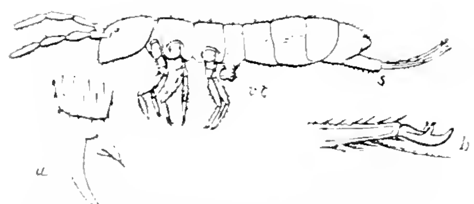


FIG 1.—*Isotoma maritima*. Magnified 25 times. (s, spring; v.t., ventral tube; a, foot-claws; b, tip of spring magnified 140 times.

Another much rarer Isotoma, *I. maritima*, Tullberg (Fig. 1), first discovered on the Swedish coast, has lately been found both on the eastern and western shores of Scotland by Mr. W. Evans.‖ The teeth of the spring in this species are very long and slender; if the end of the tooth be examined under the microscope, the thin pointed tip, and the long stiff bristle characteristic of the species can be made out (Fig. 1, b). *I. maritima* occurs on the shores of the Baltic, the North Sea, and the French coast of the Channel, but, despite its name, it is not exclusively a maritime insect. It inhabits Bohemia, and the Bohemia of modern geography, unlike that of Shakespeare's "Winter's Tale," has no sea-coast. Here, it seems, we have an insect, already almost restricted to the shore line, but still lingering on in the heart of the continent.

Two other scarce shore-haunting Spring-tails, *Isotoma crassicauda*, Tullberg, and *I. Schötti*, Dalla Torre (*littoralis*, Schött) (Fig. 2), offer a great contrast in form to *I. maritima*, as their spring-teeth are remarkably short and thick, and bear blunt, stumpy tips which differ somewhat in form in the two species (Fig. 2, b, c). *I. crassicauda* is found on the coasts of Sweden, Finland, the Shetland Isles, and northern France, while *I. Schötti*, until its recent discovery at the mouth of the Elbe and on the western Irish and eastern Scottish shores, was known only from Finland, Sweden, and Spitzbergen. Like *Machilis maritima*, therefore, these marine Spring-tails tell us of a former coast line stretching northwards from our British area, and *I. Schötti* yields evidence for the extension of this ancient shore far into the Arctic seas.

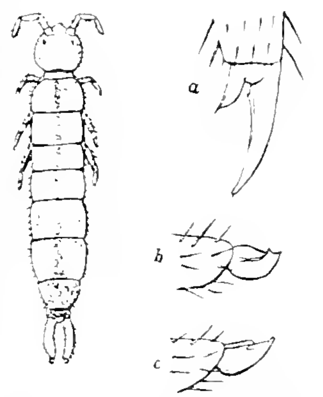


FIG. 2.—*Isotoma Schötti*, magnified 20 times. a, foot-claws; b, tip of spring, magnified 140 times; c, tip of spring of *I. crassicauda*, magnified 140 times.

FIG. 3.—*Isotoma Beselsii*, magnified 20 times. a, foot-claws; b, tip of spring, magnified 120 times.

Still further light is thrown on these problems of ancient geography by yet another rare Isotoma, lately found by Mr. Evans among wrack on the shores of the Firth of Forth. Resembling the two last-mentioned species in its short, thick spring-teeth, this one is easily distinguished by its very remarkable spring-tip. (Fig. 3, b.) Except for its single North British locality, and its occurrence on the coast of New England, its known range is altogether Arctic. Like some other, more imposing animals, it has received a different name from well-nigh every naturalist who has seen it. Lord Avebury and M. Stscherbakov described it almost simultaneously in 1898 from Spitzbergen—the former as *I. spitzbergenensis*, the latter as *I. arctica*. Last year M. Wahlgren called specimens from the lonely arctic islet of Jan Mayen, *I. janmayensis*. But it appears that Prof. Packard, so long ago as 1873, had described the same insect from Polaris Bay, Greenland, as *I. Beselsii*,¶ which is apparently the name by which we shall have to know it. The scattered points where this little insect has occurred help us to trace our old continental coast-line north of the Atlantic westward to American shores.

‡ H. Schött, "Zur Systematik und Verbreitung palearctischer Collembola." *Kongl. Svensk. Akad. Handl.*, Vol. XXV., No. 11, 1893, 100 pp., 7 pls.

§ R. Moniez, "Acariens et Insectes marins des Côtes du Boulonnais." *Rev. Biol. N. France*, Vol. II., 1890, pp. 324-6.

‖ G. H. Carpenter and W. Evans, "The Collembola and Thysanura of the Edinburgh District." *Proc. R. Phys. Soc. Edin.*, Vol. XIV., 1899, pp. 221-266, pls. V.-VIII.

¶ C. Schäffer, "Die Arktischen und Subarktischen Collembola," in Römer and Schaudinn's "Fauna Arctica." Jena, 1900.

Distinguished from the family of Isotoma by the relatively large prothorax, the frequent reduction of the ventral tube to a mere tubercle, and the presence of the spring (if one be present) on the fourth segment of the hind-body, the Poduridæ form the lowest of the three families of Spring-tails. They are lowly not because they are primitive but because they are degenerate. Among the genera of this family the spring can be traced through all stages of degradation until it vanishes altogether, and we have a paradox—like many another equally instructive in zoology—a Spring-tail without a spring.

The genus Achorutes, however, is characterised by the presence of a well-developed spring, and its most abundant species, *A. viaticus*, Tullberg, seems to be, in certain places at least, the commonest of all the insects of our coasts. Like *Isotoma palustris* mentioned above, it also abounds in many inland localities. Colonies may be found sheltering in moss, or disporting themselves on the top of a wall, or cooling themselves in a marshy hollow, or luxuriating in a rotten turnip. But they may often be found in numbers among the cast-up seaweed, and sometimes on the sea-sands they occur in vast myriads. At Aberlady, near Edinburgh, in September, 1896, Mr. Evans found these Spring-tails, 2000 or 3000 to the square foot, for several hundred yards along the shore of the Bay. The foreign range of the species stamps it as a dominant race. It is known to occur from Siberia to California, from Spitzbergen and Greenland to Tierra del Fuego.

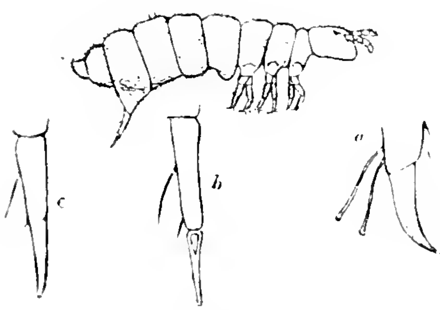


FIG. 4.—*Xenylla humicola* magnified 20 times; *a*, foot-claw; *b*, tooth and tip of spring, magnified 120 times; *c*, tooth and tip of spring of *X. maritima*, magnified 120 times.

Two rare kinds of marine Spring-tails belong to the genus *Xenylla*, which is distinguished from Achorutes by the presence of only one claw on the foot instead of two. These insects are deep blue-black in colour. One of them, *X. humicola*, O. Fab. (Fig. 4), until its recent discovery on the North German and Scottish coasts, was known only from Arctic localities—Greenland, Novaya Zemlya, and Finland. Its long tapering spring-tip is very characteristic (Fig. 4, *b*). The other species, *X. maritima*, Tullb., has occurred on the shores of Finland, Sweden, and Ireland. It furnishes an interesting stage in the degeneration of the spring, since the spring-tip is not clearly separated from the tooth which bears it, the two being fused into a single pointed process (Fig. 4, *c*). Though often found among rotting wrack, Xenylla is, despite its name, far from exclusively maritime, since it inhabits the kingdom of Wurtemburg, and has been found in northern Germany beneath the bark of trees.

Very similar in aspect to Xenylla is another blue-black insect, *Anurida maritima* (Guér.) (Fig. 5), when seen with the unaided eye walking over rocks or tangled masses of seaweed. But A[illegible] those Podurid genera in which the spring [illegible] glance with a

FIG. 5.—*Anurida maritima*, magnified 20 times; *a*, eyes and post-antennal organ of right side, highly magnified.

lens enables one, therefore, readily to distinguish this common insect from its scarce relation Xenylla. In its perfect adaptation to a saltwater home, *Anurida maritima* is the most characteristic of all our marine Spring-tails.** For it seems never to be found except between the tide-marks, and may often be observed in large companies on the surface of rock-pools. The insects' presence here, however, is, according to the observations of Prof. Moniez, involuntary. When the tide rises they shelter in crevices of the rocks, among seaweed, or in empty shells—wherever they can undergo immersion without getting washed away. The last shock of the waves as the tide recedes, often carries them out of such shelters on to the surface of the pools, where they collect together in large masses, climbing over one another. By the force of the wind, the living mass may be carried to the edge of the pool; then the outside individuals at once do their best to clamber up the rocks, never seeking to regain the sea, though sometimes an insect may, despite its efforts, fall once again into the water. The skin of Anurida is covered with numerous very minute tubercles; these ensure that the surface film shall not be broken, and thus prevent the insect from getting wetted. Even a submerged individual is surrounded by a layer of air, a gleaming silvery bubble being visible through the water.

As if to compensate them for the loss of the spring, these lowly Podurids have a mysterious sense-organ on either side of the head, between the feelers and the eyes, which attains a high degree of complexity. In some of the less degenerate Spring-tails—Isotoma, for example—this organ consists of a simple elongate-oval depression, but in the Podurids we find within the depression a number of minute prominences, usually regularly arranged and of a remarkably complex form. In *Anurida maritima*, these prominences are seven in number, and somewhat resemble the lights of a circular window (Fig. 5, *a*). From the recent researches of M. Willem,†† it seems that the structure of these prominences and of the connected nerve-endings show that smell is the function of the "post-antennal" organ. Some Podurids (Xenylla, for example) have eyes but no post-antennal organs; others (as Lipura) post-antennal organs but no eyes. Anurida rejoices in both.

Probably *Anurida maritima* is common all round the rocky parts of our coasts. It also inhabits the shores of France and Heligoland, but it has not been traced into

** A. Laboulbène. "Recherches sur l'Anurida maritima." *Ann. Soc. Ent. France* (4), Vol. IV., 1864.

†† V. Willem. "Les Yeux et les Organes post-antennaires des Collemboles." *Ann. Soc. Entom. Belg.*, Vol. XLI., 1897, pp. 225-6.

northern or Arctic regions. Nevertheless it reappears on the Atlantic sea-board of North America, and American zoologists have made its life-history the subject of detailed and careful study. Like all the Spring-tails and Bristle-tails, Anurida passes through no transformation after hatching; the tiny insect leaves the egg in a form closely like that of its parent. But the development of Anurida within the egg forms the theme of several valuable embryological researches‡‡ by Profs. Ryder and Wheeler, Miss Claypole, and Dr. J. W. Folsom. With a notice of one or two important points brought out by these investigators our study of marine Spring-tails may fitly close.

The earliest study of the growth of Anurida (Prof. Ryder's) established the interesting fact that a rudiment of the lost spring exists in the embryo, and a vestige of the organ is still present when the insect is hatched. We thus have sure evidence that the absence of the spring in the adult is due to degeneration, as there can be no doubt that, in such a matter as this, the life-history of the individual represents approximately that of the race.

In our account of the Bristle-Tail, *Machilis maritima*, the possible near relationship of primitive insects to primitive crustaceans was discussed. Every one knows, however, that while most crustaceans have two pairs of feelers on the head, insects have only one pair. But there are several insects in whose embryos a vestigial pair of appendages between the feelers and the mandibles have been observed. Anurida is one of these. At a very early stage in the progress of growth, a pair of tiny processes (Fig. 6, A, *te*) bud out from the germ band behind the feelers. There can be no reasonable doubt that these represent a second pair of feelers, lost by all

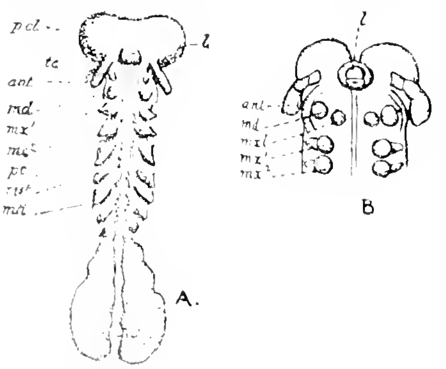


Fig. 6.—A.—Early embryo of Anurida. (After Wheeler.) *l*, upper lip; *ant*, feelers; *te*, vestigial appendages; *md*, mandibles; *mx*¹, *mx*², first and second maxillæ; *pt*, *mst*, *mtt*, the three pairs of legs. B.—Head region of later embryo. (After Folsom.) *mxl*, rudiments of maxillulæ; other lettering as in A. Highly magnified.

living insects, but retained by the great majority of crustaceans.

‡‡ J. A. Ryder. "The Development of Anurida maritima." *Amer. Nat.* Vol. XX., 1886, pp. 299-302, pl. XV.

W. M. Wheeler. "A Contribution to Insect Embryology." *Journ. Morph.*, Vol. VIII., 1893, pp. 1-160, pls. I.-VI.

A. M. Claypole. "The Embryology and Oogenesis of Anurida maritima." *Journ. Morph.*, Vol. XIV., 1898, pp. 219-300, pls. XX.-XXV.

J. W. Folsom. "The Development of the Mouth Parts of Anurida." *Bull. Mus. Comp. Zool. Harvard*, Vol. XXXVI., 1900, pp. 87-158, pls. I.-VIII.

An important structural point wherein Spring-tails agree with Bristle-tails is the possession of the paired organs at the base of the tongue—the "maxillulæ" (*see* p. 21, *ante*), believed by Dr. Hansen to represent the first maxillæ of crustaceans. Now Dr. Folsom, the most recent student of the growth of *Anurida maritima*, has traced the development of these organs in great detail. He finds that they arise from a pair of rudiments (Fig. 6, B, *mxl.*) situated between the mandibles, altogether similar to the rudiments of the other paired limbs, and having a nerve-centre (ganglion) and a division of the primitive body cavity (coelom) associated with them. There seems, therefore, no doubt that a primitive segment with paired limbs, between the mandibles and maxillæ, is indicated by the method of growth as well as by the developed structures; and further support is thus accorded to the relationship between early insects and crustaceans to which reference has already been made.

Thus we see that minute details in the obscure life-history of these humble insects of the sea-shore—details only to be learnt by long and careful research—help us to trace the history and relationships of some of the largest and most important classes of the Animal Kingdom.

RAINFALL IN SOUTH AFRICA.

By Arthur H. Bell.

The presence of so many of our troops in South Africa, as well as so many others of our countrymen who may be contemplating a prolonged sojourn there, renders the subject of the climate in which they are living an important one; and of all the elements likely to have an effect on the development and future prospects of the country none will be so far reaching as rainfall. Indeed differences in climate, after all, prove to be barriers which separate different races of men from one another, and questions of temperature may, in the long run, be found to regulate the extent to which any given class of men may advance into untried regions of the earth. At times it seems to be assumed that the Anglo-Saxon race may with impunity settle down in any quarter of the globe whatsoever, and may do so without experiencing any physiological inconvenience from submitting bodily functions and organisms to a climate to which they are unsuited. A hot moist climate may, however, prove more effective in limiting the peregrinations of adventurous races than the artifices of diplomacy or a complete equipment of modern armaments. This possibility renders the vagaries of climates in distant parts of the globe of permanent interest, and, as stated above, an important matter for consideration at the present moment is as to whether past meteorological records throw any light on the future prospects as regards rainfall in South Africa. To those who daily experience the comfort of having four brick walls between the wind and their nobility the changes in the weather are of comparatively little moment; but in opening up a new country there is much camping out to be done, and those whose lot it is to sleep under canvas are likely to find the question of rainfall an important one. Fortunately a very excellent series of rainfall observations is available for elucidating the subject, for such observations have been made in South Africa at a very large number of stations and during a large number of years, the stations being distributed over a wide area of country. The following figures are taken from a paper which appeared in the "Quarterly Journal" of the Royal Meteorological Society, and are based on the published reports of the Cape Town Meteorological Commission.

For the present purpose it will be convenient to divide the Cape Peninsula into three areas, namely, the Western Division, the Eastern Division, and Natal. The stations to which reference will be made cover an area which extends from Cape Town to Durban, and reaches as far north as Kimberley; and they are, moreover, at various heights above the sea level, and represent climates of places which like Simons Town is only 20 ft. in height, and others like Aliwal North which has an altitude of 4400 ft. Now there is a very wide range in the yearly rainfall in these various localities, and as regards the yearly averages the records show that the values range from 54.17 ins. at Bishop's Court, in the Western Division, to 8.36 ins. at Camfer's Kraal in the Eastern Division. Taking individual years, as much as 82.82 ins. has fallen during twelve months at Durban, but, on the other hand, at Camfer's Kraal the rain gauge during a certain year only succeeded in collecting rain to the amount of 3.40 ins. The most obvious fact, therefore, as regards the rainfall in South Africa, is its lack of uniformity, and not only do the amounts vary from one locality to another but there is also a lack of symmetry from year to year. In respect of the individual districts the average yearly fall over the Western area is 27.34 ins.; over the Eastern, 17.06 ins.; and in Natal, 38.21 ins., the average for all stations combined being 22.44 ins. Along mountain ranges such as Table Mountain in the Cape Peninsula, and along the Katberg and Amatola Mountains, the yearly fall varies from 50 to 70 ins. In parts covered with forests, as in T'Ztyikama on the south coast, and in Natal, the range is from 30 to 50 ins. A strip of country along the mountains near and parallel to the coast in the eastern division of Cape Colony has an average yearly fall of from 20 to 30 ins.; and a band of country along the inland side of Molepolola in Bechuanaland has from 10 to 20 ins.; while in a patch of country in the Great Karroo lying between Zwartebe[r]g and the Nieuwveldt Mountains and the extreme north-west regions of Cape Colony, the average yearly fall is under 5 ins.

The three districts mentioned above are of course drained by the Orange and Vaal rivers, and it has been calculated that they discharge into the ocean 900,000,000,000 cubic feet of water during the year. In the future administration of the country, therefore, not the least of the important problems to be solved will be those connected with devising some scheme whereby this abundant supply of water may be stored by suitable reservoirs and irrigation works, and thus rendered available for developing the agricultural resources of the country. From this point of view those who concern themselves with collecting rainfall statistics may be encouraged to continue their labours, for in the work connected with the opening up of new countries such statistics are of the highest value.

As a means of further illustrating the variation to be observed in the amount of rain which falls in different parts of South Africa, a table is appended which shows for a few selected stations the mean yearly rainfall together with the total rainfall measured during the wettest and the driest years experienced during the period in which the observations were made, a period which is in no case less than ten years. The height of each station above the level of the sea is given in brackets.

	Wettest Year.	Driest Year.	Mean Yearly Rainfall.
WESTERN DIVISION.	Inches.	Inches.	Inches.
Simons Town (20)	37·[illegible]	[illegible]3·02	30·89
Bishops Court (250)	77·82	33·08	54·17
Wynberg (250)	68·50	[illegible]	[illegible]·23
Worcester (780)	24·32	[illegible]·33	[illegible]
Capetown (50) ...	43·40	17·[illegible]	26·95
EASTERN DIVISION.			
Kimberley (3950)	30·30	9·34	16·78
Aliwal North (4400)	31·93	17·00	24·35
Brakfontein (1100)	15·91	3·52	9·76
Graff Reinet (2500) ...	24·30	6·96	14·78
Rietfontein (2270)	22·03	5·09	11·51
Queenstown (3500)	28·34	12·66	20·83
Somerset East (2500) ...	38·61	11·32	22·82
Lower Nels Poort (3100)	16·58	1·18	10·15
Port Elizabeth (180)	33·65	15·31	23·16
Camfer's Kraal (3900)	13·81	3·40	8·36
NATAL.			
Pietermaritzburg (2100)	50·98	22·41	31·46
Gardenscliffe (2270) ...	46·18	25·95	37·11
Durban (130)	82·82	28·24	43·17

THE SIZE OF OCEAN WAVES.—II.

By VAUGHAN CORNISH, M.SC.(VICT.), F.C.S., F.R.G.S., *Associate of the Owens College.*

Paris states that wind can create waves which move faster than itself, but adds that when the sea is rough the waves are always slower than the wind. He endeavours to find a relation between the velocity of wind and that of waves, but when he has eliminated all "swells," all observations in rather shallow water, and all cases where there appeared to be circumstances interfering with the required conditions, there remain only 31 days observation on which to found a generalisation. The observations on these days give the velocity of the wave proportional to the square root of the velocity of the wind. He explicitly states, however, that the number of observations is too few for the establishment of an empirical law, and wishes for the accumulation of a large mass of data, which, if carefully discussed, might show whether the above relationship is merely accidental, or if, on the other hand, it is general.

More interesting, perhaps, are the two tables (II. and III.), in which are grouped on two different plans

TABLE II.

Observations by Lieut. Paris.

State of the Sea.	Av. Veloc. Wind Feet per Sec.	Av. Veloc. Wave Feet per Sec.	Ratio Veloc. Wind to Veloc. Wave	Av. Height, Feet.	Av. Length, Feet.	Ratio Length to Height	Av. Period, Secs.
Très grosse mer	93·51	56·43	1·66	25·43	485·6	19·1	8·6
Grosse mer	65·62	45·93	1·43	16·57	347·8	21·0	7·6
Mer dure, clapoteuse, fatigante, etc.	43·96	41·01	1·07	11·65	252·6	21·6	6·2
Grosse houle ...	30·18	45·28	0·67	13·45	393·7	29·3	8·7
Houle	19·36	39·01	0·50	7·87	255·9	32·5	6·5
Belle mer	18·70	35·43	0·51	5·25	203·4	38·7	5·7

the observations of the whole 4000 waves. In Table II. the grouping is without regard to locality, being simply according to the "state of the sea." Only the mean values are here reproduced from the original

TABLE III.

Observations by Lieut. Paris.

Region	Av. Veloc. Wind. Feet per Second.	Av. Veloc. Wind. Feet per Second.	Mean Ratio Veloc. Wind to Veloc. Wave.	Av. Height Feet	Av. Length. Feet.	Mean Ratio.* Length to Height	Av. Period of Waves. Seconds.
Atlantic Trades	15 75	36·75	0 43	6 23	213 3	35 2	5 8
South Atlantic (Region of the West Winds)	44 29	45 93	0 96	14 11	436 4	31·0	9 5
Southern Indian Ocean ...	57 09	49 21	1 16	17 39	374·0	21·5	7 6
Indian Trades	21 33	41 34	0·52	9 19	315 0	35·3	7 6
Seas of China and Japan ..	47 90	37·40	1·28	10·50	259·2	24·7	6 9
Western Pacific...	27 89	40 68	0 68	10·17	334 7	33 5	8·2

* This column cannot be calculated from the two preceding columns.

table. In Table III. the *same* observations are grouped geographically. The first question which occurs to one is whether another cruise would give similar waves in the same areas. Fortunately we can compare the heights of the waves with those observed (about 1837 A.D.) on the voyage of the *Astrolabe*, of which a summary was published in 1866 (*Comptes rendus des séances de l'Acad. des sciences*, Vol. LXII.), by M. Coupvent des Bois, who was himself a member of the expedition. The method of observing the height of the waves was the same as that adopted by Paris. The velocity of the wind is also given but does not seem to be comparable with Paris' numbers. The verbal description of the state of the weather is, however, some guide in this case. (Table IV.) The average height of the waves in the trade winds of the Atlantic

TABLE IV.

Observations on the *Astrolabe*.

Scale of Numbers.	State of Weather	Velocity of Wind. Feet per Second
0	Calme moyen	3.28
1	Faible brise	9 84
2	Petite brise	16 4
3	Jolie brise	26·25
4	Belle brise	42·65
5	Forte brise	68 9
6	Grand frai	108·27
7	Tempete	164 04
8	Ouragan	239 51

It will be noticed that velocities for strong winds are quite out of accord with Paris' determinations given in Table I.

and Indian Oceans is very nearly the same in the two cases. The largest waves were met with on both voyages in the southern Indian Ocean. The results for the Pacific Ocean differ much; I doubt however, if the area included by Paris under "Pacific west," is the same as the western part of the "Océan Pacifique equatorial" of Des Bois, so that the difference of results may have but little physical significance.

Des Bois' method of grouping the waves in longitudinal strips of 30° is convenient. In the equatorial Pacific (0° to 30° lat.) the mean force of wind and the mean height of the waves diminished from east to west, being near the Asiatic coast only ¼ to ⅓ of the height near the American coast In the equatorial Indian Ocean the winds and waves were highest in the middle. In the equatorial Atlantic the waves were highest on the western side, although the winds were strongest in the east. In the centre there was a medium height of wave combined with the lowest force of wind. In the latitudes 60°-66° S. we note the strongest winds with relatively low waves I suspect that the relatively small height of wave is due to floating ice, which, as Nordenskiold has pointed out, has a marked effect in smoothing the sea The total number of observations was about 7200. I infer from the text that the height of the waves was not actually measured at each observation, but that sufficient measurements were taken to satisfy the person responsible for the work as to the height of wave which corresponded with the entry "state of the sea." This state of the sea was noted six times daily, each such note constituting, I suppose, one "observation," from which the average heights given in Table V. were afterwards

TABLE V.

Observations on the *Astrolabe*.

Compare last column with column 4 of Table II.

	Long.	Velocity of Wind. Feet per Second.		Height of Waves in Feet	
Equatorial Pacific Ocean (0°—30° lat.)	75-110W	15·42	av. 13·45	11·48	av. 5 69
	110 140 ,,	13 78		6 56	
	140-170 ,,	14·44		4·92	
	170W-160E	13·45		3·94	
	160-130E	13·12		3 94	
	130 100 ,,	10·50		3 28	
Equatorial Indian Ocean (0—30 lat.)	120 90 ,,	15·75	av. 19 14	6 89	av. 8·42
	90- 60 ,,	25 92		11·81	
	60- 30 ,,	15·75		6·56	
Equatorial Atlantic Ocean (0—30 lat)	10E.-11W.	18 70	av. 15 75	4·26	av. 6·12
	10W.-30 ,,	13·45		6·56	
	30—50 ,,	15·09		7 55	
30 50	All longitudes		14 11		7·22
50 —60 S	Méridien d'Amerique	15 09	av. 17.06	6 89	av. 10·67
50 —60 S.	Méridien Nouvelle-Hollande	19·03		14 14	
60 - 64 S.	Méridien d'Amerique	24·94	av. 24 45	6 89	av. 6·89
60 —66 S.	Méridien Nouvelle-Hollande	23·95		6 89	

calculated This connection between "state of the sea" and height of wave, found by measurement is given in Table VI This should be compared with Paris Table III.

The following observations of waves were made by the Hon. Ralph Abercromby* on board the s.s. *Tongariro*, in various parts of the South Pacific, between New Zealand and Cape Horn, in 1885. The observations of height were made with the aid of a 4½ inch aneroid, with a very open scale divided to 0 01 of an inch. Altitudes were calculated on the assumption that 0.001 inch difference of pressure corresponds to

* Observations on the Height, Length, and Velocity of Ocean Waves, read before the Physical Society, February 25th, 1888, published in the *Philosophical Magazine*, April, 1888 (Vol XXV., 5th Series).

1 foot height. It was considered that the errors of height due to the aneroid were never more than 2 to

TABLE VI.

Observations on the *Astrolabe*.

Numbers recorded in the Log.	State of Sea.	Height of Waves. Feet.
7	Très grosse mer	28·54
6	Grosse mer	20·67
5	Très grosse houle	15·42
4	Grande houle	10·83
3	Houle	7·55
2	Petite houle	4·92
1	Belle mer	3·28
0	Mer unie	1·97

Compare with columns 1 and 5 of Table II.

2·5 feet. The greatest source of error in the opinion of the observer occurred in the estimation of the height of the eye above sea level. For instance, he says, when the aneroid was at its lowest point the surface of the water might be 10 feet below the eye; but when the crest of the wave was passing, the height might be reduced to 1 or 2 feet. Here the observer had to trust to estimation by the eye aided by a few rough measurements with a piece of string down the ship's side, and the error here, he considers, may be at least 2 feet either way, or 4 feet in all. Observations for length and speed were taken in much the same way as those of Paris, with the advantage, however, of a flyback chronograph over an ordinary seconds hand watch. Abercromby mentions two difficulties in obtaining good results, viz., that two successive waves rarely ran in exactly the same direction, and that, with a heavy following sea the ship yawed about so much that the angle between her course and that of the waves could only be estimated approximately. Really big waves were met with on only 3 days. On June 8th, 1885, in lat. 47° S., long. 175° W., the sea was too irregular to measure individual wave heights or lengths, but the barometer indicated about 12·5 feet vertical motion of the point of observation below decks. The surface of the sea was pretty constantly about 7 feet below the port-hole in the troughs, and 1 foot at the crests. This gives an average height of the waves 18·5 feet. The velocity of the waves was pretty constant, although the length appeared to be so irregular, five observations giving speeds of 29, 28, 31, 33 and 30 miles per hour (average 30.2 miles). On June 10th, in lat. 51° S., long. 160° W., the observer availing himself of the previous determination, assumed a constant difference of six feet between the height of the aneroid above water level at crest and trough, and added this to the observed variation of the aneroid. Individual waves were observed with heights of 26, 21, 23·5 and 26 feet, but the indication of the aneroid indicated that the difference of absolute level between the lowest trough and the highest crest (not one of those recorded above) was 35 feet. I suppose the inference from this to be that the difference, if a real one, was due to the presence of a long swell susceptible but not visible in the rough sea, and I apprehend that the revelation of such [illegible] but not negligible waves is one of the special advantages of the aneroid over eye observation. The velocity and length of waves was measured just before the heights were taken; three determinations gave the following results:—

Velocity.	Length.
[illegible]	[illegible]
30·5	[illegible]
28·5	[illegible]

This sea, Abercromby [illegible] as 6 or 7 on the ordinary scale of [illegible] was blowing a moderate to hard gale [illegible] heavy squalls, and was logged 7 on Beaufort [illegible] 0—12. During some of the squalls the force rose to [illegible] sea, he says, might be taken as a fair average in the South Pacific, the waves were far too irregular to allow of any attempt being made to determine the ratio of height to length or velocity. On July 16th, 1885, lat. 55° S., long. 105° W., larger waves were observed during which the greatest vertical lift of the aneroid in the cabin was undoubtedly 10 feet. If the difference of water level outside was again 6 feet the height of the waves was 16 feet, but of this the observer, who confined his attention to the aneroid, was not sure. The measured velocities and lengths were:—

Velocity.	Length.
35·5 miles per hour	115 feet
35·5 ,,	185 ,,
17·5 ,,	705 ,,

The author states that the want of harmony between the length and velocity on the one hand, and the height on the other, was not due to errors of observation. On all the days the waves were running irregularly; he did not see any crests nearly a mile long chasing one another with a well defined trough between. There was nothing to call a cross sea, but there were many series of waves of different lengths running pretty much in the same direction which were constantly interfering with one another. He generalises from his experience (which it must be mentioned were by no means confined to the voyage of which he here speaks) in the statement that the great discrepancies in the observed elements of waves given by different observers is doubtless due to the co-existence of several series of undulations, which, therefore, always make a more or less confused sea.

The author concludes with suggestions for a wave-measuring party, which he says should be composed of three members, A, B, and C. C would have charge of two chronographs, and B of the aneroid. They would confine their attention to reading the instruments, whilst A only would watch the sea. He would observe the arrival and passage of the wave crests, the height of the water against the ship (by marks on the side) at crest and trough, and he might have to read a simple clinometer also to allow for the roll of the ship.

(*To be continued.*)

CONSTELLATION STUDIES.

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

III. THE REGION OF VIRGO.

The Great Bear still holds the zenith at midnight throughout the month of March, but by the middle of the month the Lion has ceased to be the dominant constellation in the south. Its place is taken by the Virgin, which seems almost to be [illegible] regal beast, for at this time of the year the ecliptic [illegible] downwards more sharply than at any other [illegible] descending node lies close to the boundary of Leo and Virgo and just within the latter constellation. Virgo, therefore, is easily found when Leo is known, or the old rhyming direction will plainly point it out:—

[illegible] the Pole Star through Mizar glide
With long and rapid flight
[illegible] end, and see the Virgin's [illegible]
Diffuse its vernal light.
And mark what glorious [illegible]
By the gold harvest's ears
[illegible]
A tri[illegible]."

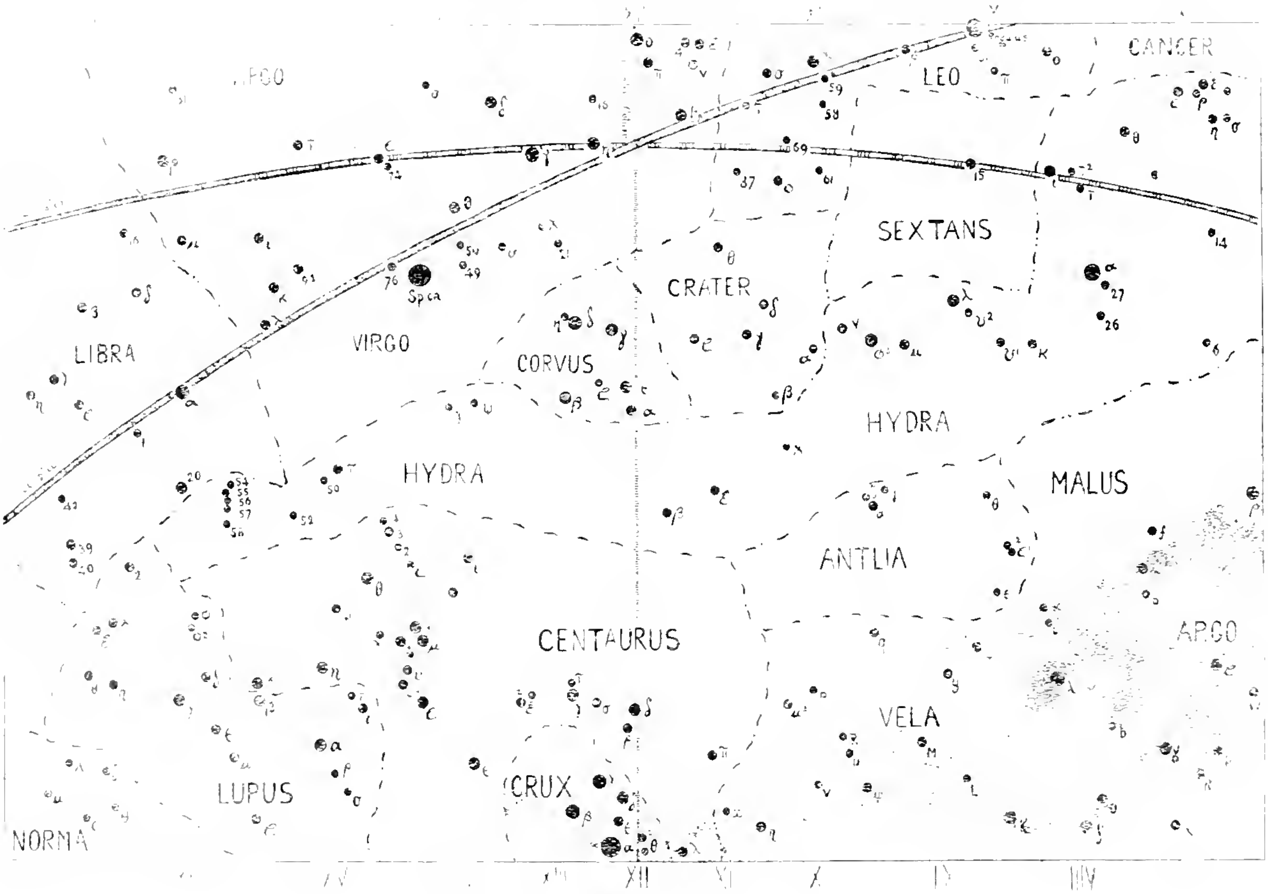
Denebola of the Lion [illegible] triangle with Arcturus [illegible] the Virgin.

The chief stars of [illegible] make an irregular capital Y [illegible] the stem and lower branch of the Y [illegible] the ecliptic. That [illegible] marked out in this portion of the [illegible] the Twins, the bright star below Pollux [illegible] that hero's right hand; Delta in Cancer [illegible] of the two asses; Regulus

spirit of Justice, once in the Golden Age a dweller amongst men. But when an inferior race in the Silver Age succeeded to their fathers, she withdrew to the mountains, and fled thence to the sky when the Brazen Race fashioned murderous weapons and devoured the flesh of plough oxen for their food. The account of her which is still most generally received, is that she represents the wheat harvest; the ear of corn in her hand which one would have thought a fitter symbol of sowing, being taken as representing the garnered sheaves. But this cannot be the case, for Aratus tells us—

"As rushing on his prey,
The lordly Lion greets the God of day,
When out of Cancer in his torrid car
Borne high, he shoots his arrows from afar,
Scorching the empty fields and thirsty plain,
Secures the barn the harvest's golden grain;"

proving, as Brown points out, that Spica was not asso-



Star Map No. 4.—The Re[illegible] Virg[illegible]

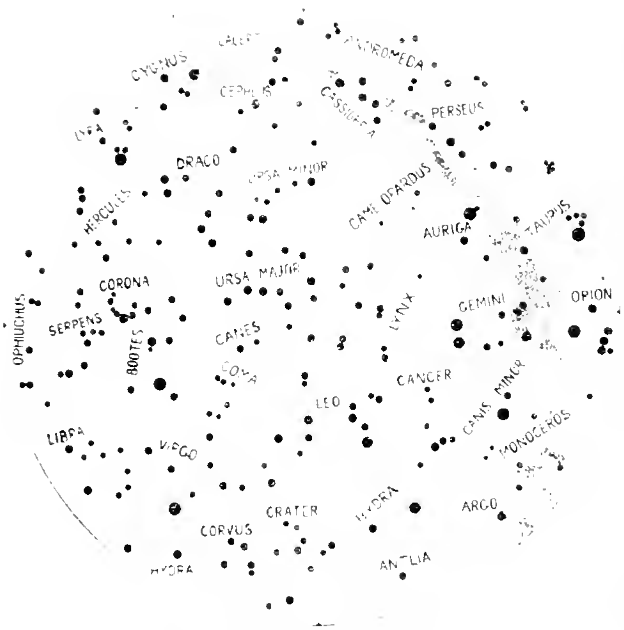
[illegible] Leo ar[illegible] and Rho and Tau [illegible] the line to the boundary [illegible] from the [illegible] which [illegible] of [illegible] Virgo [illegible] central [illegible] Spica [illegible] the [illegible] into Libra. The [illegible] Y is marked by Delta and Epsilon [illegible] marks [illegible] Y [illegible] of double stars.

Aratus gives more space to the [illegible] of this constellation than to any other. With [illegible] the

ciated originally with the harvest, since this had been already reaped when the sun entered the Lion. A further proof is afforded by the old name of Epsilon Virginis, "Herald of the Vintage," the vintage necessarily falling considerably later in the year than the harvest.

The constellations of the Zodiac, if intended to mark the several months of the year, should being twelve in number, stretch each of them over 30° of longitude, neither more nor less. As a matter of fact they are of most irregular length, Cancer extending only over 18° or 19°, whilst Virgo covers about 50°. At an early period therefore, the ecliptic was divided into twelve equal portions, not constellations, and having no direct connection with the [illegible] arrangement of the stars, but deriving their names from the constellations which most nearly corresponded to them. These were the Signs of the Zodiac as distinguished from the Constellations of the Zodiac, and the distinction between the two is one that it is important to bear in mind. The months of the year never did, and never could have, corresponded with the actual constellations; the Signs being purely arbitrary divisions could always be made to correspond with the months. Since, then, the constellation figures are clearly older than the equal signs, it is manifest that none of the many schemes which have been framed to account for the Signs of the Zodiac by the climatic changes of the successive months in this or that country can have any basis in fact. The constellation figures were in existence long before the correlation of signs and months was effected.

The Accadian calendar connects the sixth sign of the Zodiac with Ishtar, the "daughter of heaven," the moon in one aspect, and the planet Venus in her twofold



The Midnight Sky for London, 1901, March 7.

character of morning and evening star in another. Early Christian thought recognized a reference to the promise of "the Seed of the Woman" of Genesis in [illegible] "the ear of the corn," the Virgin carries in her hand, and the expression in Shakespeare's play of Titus Andronicus "the good boy in Virgo's lap" refers to the mediæval representation of the sign as the Madonna and Child.

The region of the sky enclosed between the two arms of the Y and Denebola of Leo is near the pole of the Galaxy, and is the wonderful Nebulous Region. Here these strange bodies are to be found by the hundred, clustering more thickly than in any other portion of the sky.

Close below Virgo are two small but fairly bright constellations, the Cup and the Crow; the Cup lying underneath the Virgin's shoulder, the Crow beneath her hand. The latter constellation is very easily found. Delta Corvi forms with Alpha and Gamma Virginis almost an equilateral triangle, and the line from Alpha Virginis to Delta Corvi leads to Gamma Corvi. When on the meridian two other stars of about equal brightness,

Epsilon and Beta [illegible] Delta and run up with them a [illegible] Beta Virginis and Delta Corvi [illegible] with Delta Crateris [illegible] of the Cup, a somewhat faint [illegible] Crater [illegible] one, mark the foot of the Cup. [illegible] are commonly represented [illegible] a huge, winding snake, the longest [illegible] sky, Hydra, which stretches across some 90 [illegible] Its head begins close to Procyon under Cancer, and it stretches below the zodiacal constellations of Cancer, Leo and Virgo and the greater part of Libra. It has few bright stars, and these not grouped in easily remembered figures; and the great reaches of barren sky it includes seem referred to in the name given to its brightest star, Alphard, "The Solitary." Alphard may be readily found by prolonging a straight line from Gamma Leonis through Regulus, and dropping a perpendicular on it from Procyon. The myths connected with the three constellations have no very great interest. Brown finds Hydra, a "storm and ocean-monster." "The quick flowing rivers seem to have been compared by the Akkadians with the swift gliding of a huge glistening serpent, and so we arrive at the idea of the River of the Snake, which develops into an Okeanos stream like the Norse great serpent, the Midgard Snake." The Cup becomes thus a "symbol of the vault of heaven wherein at times storm, wind, clouds, rain are chaotically mixed"; and the Crow, or rather Raven, is the constellation of the Storm-Bird. Carl G. Schwartz, who at the beginning of this century interpreted the constellations as being a sort of symbolical geography of the countries on the west shore of the Caspian, thought these three constellations represented the petroleum wells of Baku. The great extent of the Hydra, with its folds and knots, show, beyond mistake in his opinion, the slow oily flow of crude petroleum; the Cup is placed there to indicate the liquid which would have to be held in a cup or some such reservoir, whilst the Crow indicates its inky blackness!

Of these three constellations, Crater is perhaps the best for opera-glass examination, yielding some pretty fields. Zeta Corvi, the faint star nearly midway between Epsilon and Beta, shows with the opera-glass as an interesting little double, whilst a much closer pair will be found near Beta and slightly preceding it.

Erratum.—In column 2, page 34, of the February number of Knowledge, the eighth line from the bottom is to be omitted.

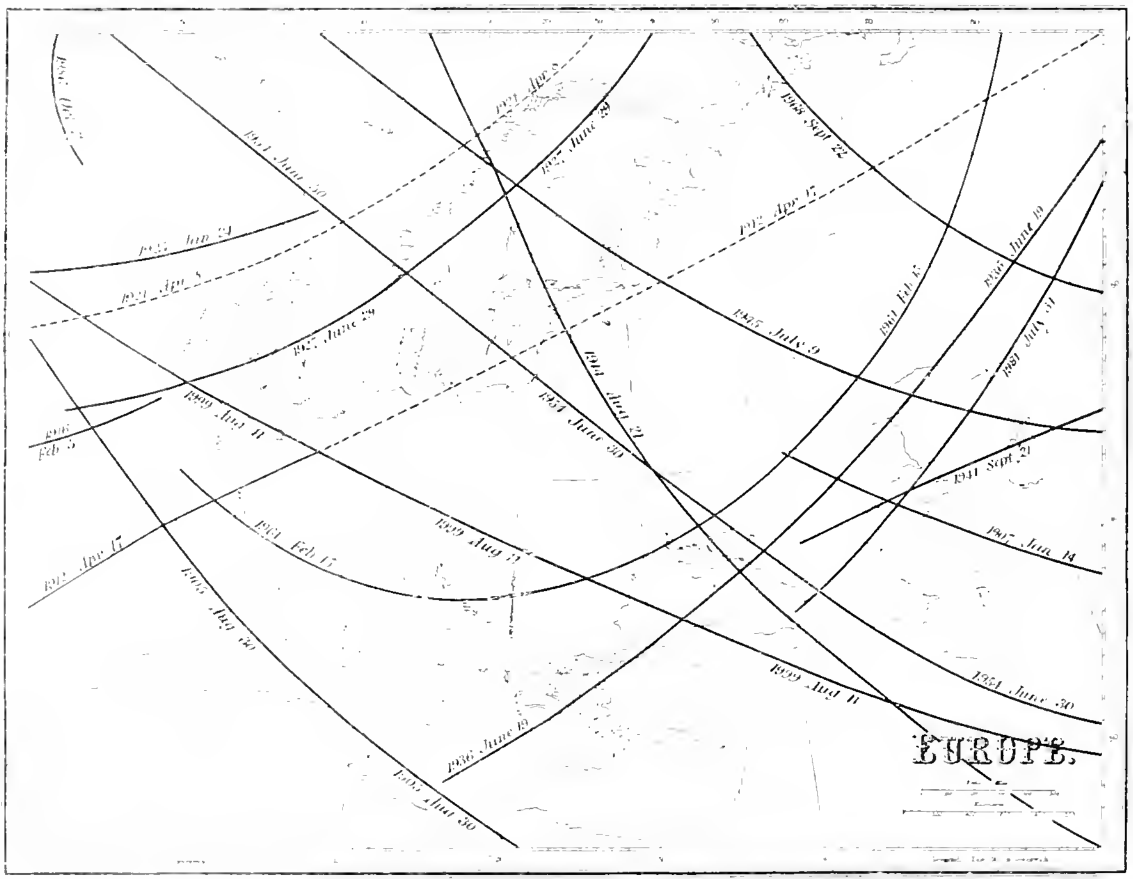
TOTAL SOLAR ECLIPSES OF THE TWENTIETH CENTURY.

By A. C. D. Crommelin.

Standing as we do on the threshold of a new century, it seems a fitting occasion to examine what opportunities it will afford of witnessing that grandest of celestial phenomena—a total solar eclipse—and of unravelling the mysteries which still hang thickly about the sun and his surroundings. It is clear that eclipses visible in Europe are especially interesting to us, as they are accessible to a much greater number, and give opportunity for more complete series of observations. I have prepared a diagram showing the tracks of all the total eclipses that cross Europe or the regions adjoining it during the coming century. These tracks do not claim absolute accuracy, but they are very near the truth. I have in each ca[illegible] [illegible]ulated as many points as seemed necessary from the Tables in Oppolzer's Canon, and then drawn the track through them by hand, except for the eclipses of 1913, 1927, 1999, for which I have made use of the elements given by Dr. Hind in "Nature," Vols. XII., XIII., XXXI., and that of 1905, for which I have made use of a map published by the Madrid Observatory.

Two European countries seem especially favoured at present, viz., Spain and Norway. Spain has had total eclipses in 1842, 1860, 1870; it had one in the past year, and others in 1905, 1912. Norway has had them in 1816, 1851, 1896, and has others in 1914, 1927, 1945, 1954.

I commence with the eclipse of August 30th, 1905, which is a very favourable one, the track being 2½ times as broad and the duration 2½ times as long as that of the past year.



Di[illegible] all Total Solar Eclipses that cross Europe during the Twentieth Century.

The central line run[illegible] Vivadez in Oviedo to Torreblanca, passing [illegible] Burgos, which will be a very convenient and [illegible] station to view it from, the duration of totality th[illegible] 3m. 47s., a very unusual amount for a Europ[illegible]. The width of the track is about 120 mi[illegible] [illegible]thern limit runs approximately from Corunna to V[illegible] the northern one from a little west of Sant[illegible] [illegible] what south of Tarragona. This eclipse ma[illegible] observed in Labrador, the Balearic Isles and Tun[illegible]

Passing over the eclipse of 1907, which is total soon after sunrise on the shores of [illegible]e Caspian, we come to that of 1912. This belongs to that rath[illegible] rare class of eclipses which are total near the middle of the shadow track but annular at the beginning and end. The track enters Portugal near Aveiro and runs north-east, leaving Spain some 12 miles east of Gijon. It then traverses France, passing very near Paris, and across Belgium, Germany and Russia. In Portugal there will be about 7 seconds of totality, in the west of France a second or two, and further east the eclipse will be only annular.

Short as the totality is in Portugal it should be possible to obtain photographs of the inner corona, and the flash spectrum may be photographed round the whole limb of the sun, which should yield results of great interest and value.

The eclipse of 1914 crosses Norway, Sweden and Russia. The central line enters Norway at Alstahoug in latitude 66°, the duration of totality being two minutes. It runs south-east, intersects the railway running east from Trondhjem, leaves Sweden near Bramon I., intersects several islands in the Baltic, and then takes a course across Russia from Riga to the Crimea. Those who journey by sea have thus the choice of four distinct coasts, in addition to the islands.

The eclipse of 1916 ends near the south coast of Ireland. The track of totality passes very near to, and may actually intersect, the island of Corvo in the Azores, so that this may be available as an observing station. If not, it will be necessary to go to Guadaloupe or Venezuela.

The eclipse of 1921 is inserted in the map, though only an annular one, since it is the next central eclipse in the British Isles. The last total eclipse in the British Isles was in 1724, but there were annular eclipses in

1806, 1867, 1858. The central line [illegible] crosses the island of Lewis, and onwards to the Lofoden Islands.

The eclipse of 1925 is total near Boston, U.S.A. [illegible] does not appear to touch land on this side of the Atlantic.

In 1927 we have the next totality in the British Isles. The central line runs from near Anglesea to North Yorkshire, where totality will last about 24 seconds. Dr. Hind gives it as [illegible] seconds, but this seems to me to be clearly too small. The track then goes right up the backbone of Norway, and passes out near Vadso, which was occupied as an eclipse station in 1896, and may again be occupied, as the duration of totality there is considerably longer than in southern Norway; our weather experiences in 1896, however, were not very encouraging.

The eclipse of 1936 may be well observed from Constantinople; that of 1945 from Norway, Sweden or Finland.

In 1951 we may have another totality in the British Isles, as Dr. Hind considered that the northernmost of the Shetlands would lie within the shadow track; in any case it will be observable in southern Norway.*

The remaining eclipses do not need much comment. The eclipse of 1961 may be well observed in Italy and Turkey. In 1966 there will be a very brief totality in Greece. It is not shown on the map. In 1999 occurs the third totality of the century in the British Isles, and the most favourable of all.

The north limit of totality passes approximately through Tintagel Head, Exmouth and Weymouth; the central line from St. Ives (Cornwall) to Prawle Point. Hence the shadow will cover nearly the whole of Cornwall and the southern portion of Devon. The duration of totality will be just two minutes. This eclipse will also be visible in North France (the central line runs from St. Valery to Laon), Germany, Austria and Turkey.

Many interesting illustrations of the Saros cycle or period of 18 years 11 days, after which eclipses recur, may be derived from our eclipse map. This cycle was explained in an article by Mr. Walter Maunder in KNOWLEDGE for 1893, Vol. XVI., p. 181. Each recurring eclipse moves westward about 120° of longitude, so that after 54 years we get an eclipse in about the same longitude, but north or south of the first according as the Moon is at a Descending or Ascending Node.

The eclipses of 1882 (Egypt), 1900 (Spain), 1918 (United States), 1936 (Greece), 1954 (Shetlands), are an example of an eclipse moving slowly northward.

Again, the eclipse of 1860 was visible in Spain; after three more Saroses it crosses Norway in 1914, while three more bring it to north-east Russia in 1968; after one more return in 1986 west of Iceland the eclipse ceases to be total.

As an example of a southward moving eclipse that of 1851 was total in South Norway; after three Saroses it crosses Spain in 1905, while in 1959 it will cross the Sahara.

Again, the eclipse of 1927 returns in 1945 and after three more Saroses it gives us that of 1999.

While conveying a general idea of the locality where an eclipse will recur, the Saros is not exact enough to predict the track of a future eclipse with great precision. Major-General Strahan, in his report on the Indian eclipse of 1898 [illegible] eclipses of [illegible] next century, by [illegible] many of [illegible] checks [illegible].

It would [illegible] not European totalities [illegible] important eclipses of the next [illegible] been already mentioned [illegible] list.

1901. Mauritius, Sumatra, N[illegible] (long totality).

1904. Pacific Ocean (long totality).

1905. Labrador, Spain, Tunis, Egypt.

1907. Caspian, Turkestan, Mongolia.

1908. Pacific.

1911. Pacific.

1912. South America (Bogota to Rio Janeiro).*

1918. North America (Vancouver to Florida).

1919. Brazil, Gold Coast, Lake Tanganika (long totality).

1922. Australia (long totality).

1923. North America (San Francisco to Jamaica).

1925. North America (Lake Superior to Boston).

1926. Victoria Nyanza, Amirante Islands, Sumatra.

1929. Sumatra, Malay Peninsula, Philippines.

The next thirty years afford on the whole a more favourable series of eclipses than the last thirty years, and as many of them are in reasonably accessible localities, it is to be hoped that they will be extensively observed, and unravel many problems of solar physics that are still veiled in mystery.

SUNRISE ON THE SEA OF PLENTY.

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

The region of the Moon shown in the present plate, which is taken from the fourth number of the magnificent Atlas Photographique de la Lune, published by the Paris Observatory, exhibits under the double influence of strong foreshortening and sunrise illumination, a striking amount of relief; and the nearness of the terminator to the limb accentuates a feature, common indeed to the whole lunar surface, but here seen most strikingly, namely the tendency for the chief formations to dispose themselves along meridians. Thus we find the narrow strait of light, lying between the terminator and the limb, is almost exactly bisected by a succession of great walled plains, Petavius, Vendelinus and Langrenus,—all on the 60th meridian. This meridian in its sweep northward, traces out the western boundary of the Mare Fecunditatis, cuts through the ring-plains, Webb and Apollonius, and bisects the Mare Crisium. In this latter Mare, we see the influence of these meridianal forces marked in still greater detail, since it is crossed by a number of ridges, one of which is especially distinct on the photograph, which streak it from north to south; a clear indication that the tidal attraction of the earth when the moon's crust was still in a plastic condition was a chief agent in moulding the surface into its present shape.

The Sea of Conflicts, from the beauty of its surroundings and the strong relief into which it is thrown whilst the crescent moon is still [illegible] has always been a favourite object of study. [illegible] convenient, it can be examined as a whole, and the definiteness of its outline makes it the more suitable for such study. In length, east and west, it [illegible] to 355 miles, wh[illegible] its

* I am informed by Rev. S. J. J[illegible] Dr. H[illegible] considered also that the shadow would [illegible] Shetlands [illegible] be farther North.

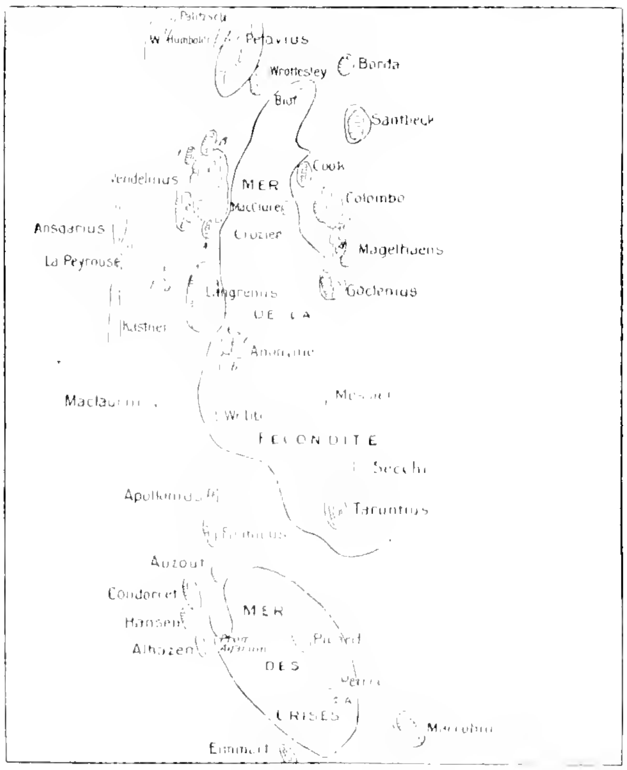
* There will [illegible] in 1912 [illegible] eclipses six [illegible] apart, which is a very rare occurrence.

length, north and south, is but 280. It is thus elliptical in reality, as it is also in appearance, but its major axis, through the effect of foreshortening, shows as if it were the minor.

The Mare Crisium was the subject of the Plate in KNOWLEDGE for March, 1893, two years ago; but it was then shown under sunset illumination, whilst in the present Plate, the morning light is full upon it. The western border, therefore, was entirely lost in night in the former representation, and the eastern highlands were too strongly illuminated for their intricacies to be followed as clearly as they can be now. The magnificent mountain group which forms the southern boundary of the Mare, can also be examined better under the present lighting; its broad deep bays and winding valleys being seen under the most favourable conditions.

The western frontier is quite of a different character from the others, being a broad, gently sloping plateau; and the extension on the west of the Mare which begins under the shelter of the great southern promontory, Cape Agarum, and which appears on the photograph to be marked off from the main body of the Mare by a very distinct ridge, would seem probably to be a later development, an annexation after it had attained its original form of a nearly perfect hexagon.

The centre of the Plate is occupied by the Sea of Plenty, which however is not shown here quite in its entirety. It covers an area of 160 thousand square miles, stretching some 640 miles from north to south, 410 from east to west. It narrows, however, greatly towards the south, being only 130 miles wide where Vendelinus borders it, so that its shape as a whole is that of a pear. The photograph brings out in strong relief the successive ridges by which the plain rises from its lowest depth,—



Sketch Map.

situated almost precisely at the centre of the Plate,—up to its western border, and which mark the stages of the subsidence of the crust.

Immediately to the west of the Mare, is the beautiful walled plain of Langrenus, which in the completeness of the example which it offers of eruptive action may be considered the Copernicus of this region of the moon, and indeed it is not much inferior to the latter in perfectness of outline, whilst it considerably exceeds it in dimensions. The walls of Langrenus, however, do not rival those of Copernicus in height, and its system of light streaks falls far short of that which crowns the beauty of the monarch of the Carpathians. The great walled plain at the top of the photograph is Petavius, nearly 80 miles in diameter, surrounded by a lofty mountain wall, double on nearly every side but the north, where it is lower and broader. Two of the leading features of the formation come out on the photograph with especial distinctness; one the central peak, and the other the rill that leads from it in a south-easterly direction, right up to the wall of the plain.

Between Petavius and Langrenus lies Vendelinus, a walled plain as extensive as its two neighbours, but destitute of their symmetry and completeness, but for that very reason a more interesting region to study. Midway between Petavius and Vendelinus but further from the limb, is Petavius B, a deep ring plain, standing in a bright elevated region. The brightness of this region renders it one of the most conspicuous markings in the Plate, and is an evidence of its relative newness.

A very cursory glance at the limb of the Moon is sufficient to show that it is far from being a true curve, a very distinct flattening being very perceptible about the centre. This is of especial interest, inasmuch as it gives some suggestion of an answer to the question we so vainly ask, "What does the other side of the moon look like?" It would seem that we have here another of the great grey plains which on the visible disk we call *maria*. It is the Mare Smythii, and its presence justifies us in inferring that the unseen three-sevenths of the moon's spherical surface does not materially differ in general character from the four-sevenths we know. Like it, it would present, could we examine it, bright broken highlands and broad sombre plains, and every variety of lunar structure from the great walled plain to the smallest craterlet.

Letters.

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

THE PATH OF THE SUN.

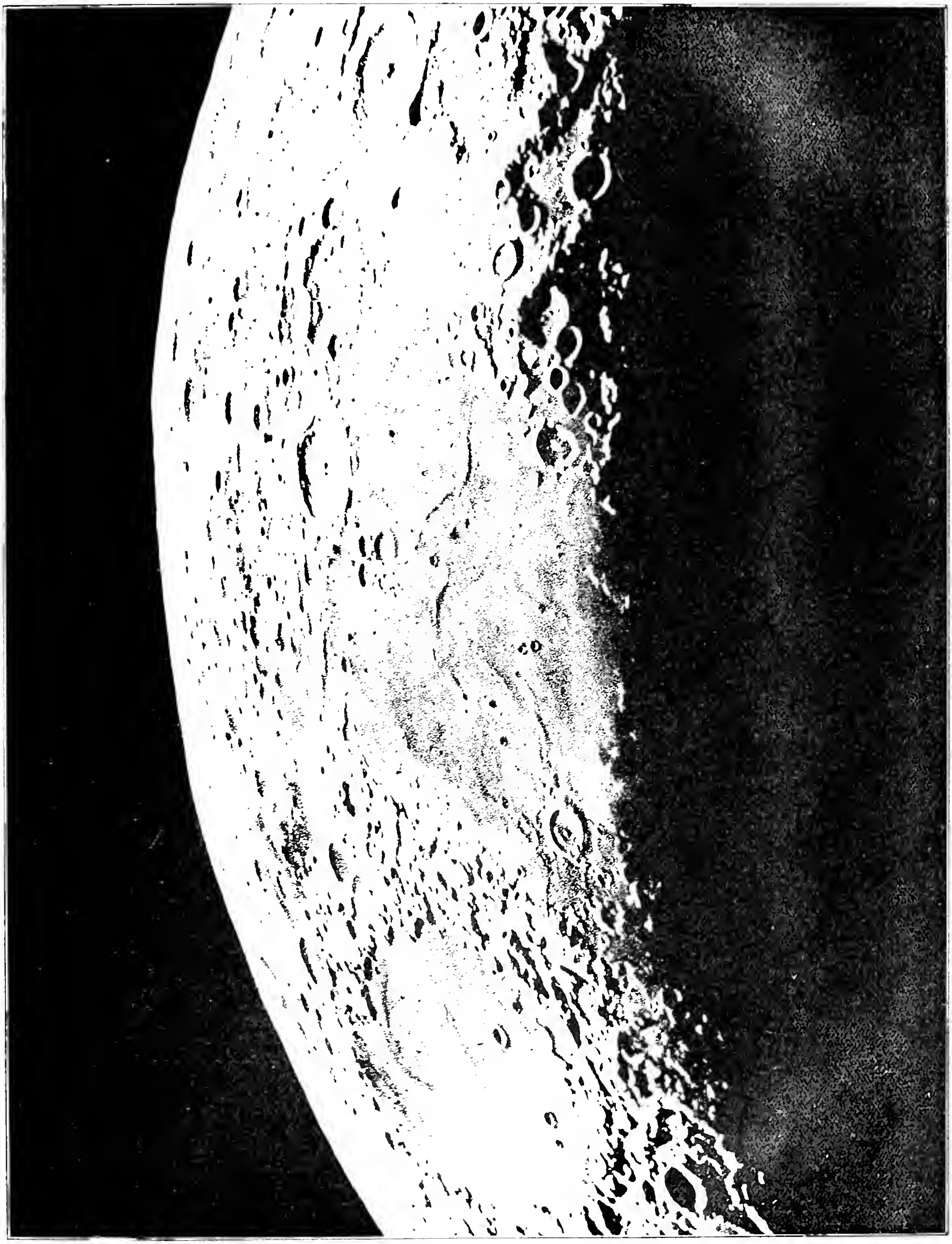
TO THE EDITORS OF KNOWLEDGE.

SIRS,—In the notice of my work under the above title in your January issue, an adverse opinion is expressed, and with your permission I desire to suggest a reference to facts of such a character that they will either effectually destroy my theory of the Sun's course or establish its truth.

Just as it is essential for the truth of precession that the south pole of the heavens should describe a similar circle to that of the north pole, so is it requisite for the establishment of my case that the south pole should not move in a circle but remain in one spot; and if proof of its motion can be furnished, I will admit the fallacy of my arguments.

If, on the contrary, observations show that the south pole is a fixture, no other theory but mine can account for such a phenomenon; nor can the doctrine of precession be maintained in face of a fact so contradictory.

I will only add that while abundance of evidence exists as to the present position and revolution of the north



SUNRISE ON THE SEA OF PLENTY.

pole, all we are told of the south pole is that it is in a certain place, and I desire an answer to the question, Does it remain there? WM. SANDEMAN.

14th January, 1901.

It is rather extraordinary that Mr. Sandeman, after having studied this subject for so many years, and writing so confidently upon it, should never have applied so simple a test to his theory himself. It is still more extraordinary that he should assume that astronomers who have been observing accurately the places of the southern stars for a century and a half have not yet ascertained whether they showed the effects of precession or not. However, the answer is simple; the south pole of the heavens moves in exact accordance with the north pole. A pair of stars taken from the neighbourhood of each pole will show this clearly. Nos. 6 and 1631 of Bradley's Catalogue are in R.A. 0h. and 12h., and are distant from the north pole 13° and 12° respectively. β Hydri and γ Muscæ have similar R.A.'s, and are distant from the south pole 12° and 18° respectively. Now if we compare Lacaille's Catalogue for 1750 with the Cape Catalogue for 1890; and Bradley's Catalogue reduced to 1750, with the Radcliffe Catalogue for 1890, we get the following apparent changes in the places of the stars due to the actual motion of the poles.

	R.A. 1750.	R.A. 1890.	Diff.	S.P.D. 1750.	S.P.D. 1890.	Diff.
	h. m. s.	h. m. s.	m. s.	° ′ ″	° ′ ″	′ ″
β Hydri	0 12 12·0	0 20 [illegible]	7 [illegible]	11 20 [illegible]	12 7 31	+47 22
γ Muscæ	12 17 51·0	12 25 [illegible]	+7 [illegible]	1[illegible] 1[illegible] 7	18 28 20	[illegible] 16 38

	R.A. 1750.	R.A. 1890.	Diff.	N.P.D. 1750.	N.P.D. 1890.	Diff.
	h. m. s.	h. m. s.	m. s.	° ′ ″	° ′ ″	′ ″
Bradley 6	0 2 31·3	0 9 [illegible]	7 28·3	14 26 23	13 [illegible]	−46 45
Bradley 1631	12 0 [illegible]·7	12 7 [illegible]	6 [illegible]	10 [illegible] 37	11 16 21	+46 16

The figures show that the north pole has moved in the 140 years about 47′ downward towards Bradley 6, whilst the south pole has moved away from β Hydri on the same meridian, almost exactly the same distance.—THE REVIEWER.

SUNSET PHENOMENON.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Before the rains started here at the beginning of summer a strange phenomenon was occasionally observed at sunset. From a point in the east, exactly opposite where the sun was disappearing below the horizon, rays of light streamed out, extending a considerable distance. It looked just as though the sun had gone down in the wrong place, and when there were rays from both east and west the effect was very striking. Can you give me an explanation in one of the numbers of the paper?

P.O. Box 66, R. L. McDONALD.
Bulawayo, Rhodesia.
10th January, 1901.

[The phenomenon is essentially of the same character as the familiar one which children call "the sun drinking," when, in somewhat hazy weather, the shadows of clouds stand out in the moisture-laden air. So, under certain circumstances, about a quarter of an hour after the sun has gone down, we may occasionally see similar shadows apparently radiating from the Sun's place. These are likewise the shadows of clouds thrown upon the air full of moisture or of dust. The beams are in reality parallel straight lines, but from the effect of perspective they seem to radiate from the sun's place, and to converge again to a point directly opposite to it. It is, however, rare for them to be traced entirely across the sky, and as the air overhead is necessarily freer from the minute particles which make the beams evident, they can very seldom be traced across the zenith even when they are seen near their converging point in the east.—E. WALTER MAUNDER.]

NOTES.

ASTRONOMICAL.—At the annual meeting of the Royal Astronomical Society on February 8th, the Gold Medal of the Society was awarded to Prof. E. C. Pickering, the well-known able and energetic Director of the Observatory of Harvard College. In the course of a letter expressing his appreciation of the honour, Prof. Pickering made the interesting announcement that with an instrument of only 8 inches aperture, he is now able to photograph the spectra of stars down to the 13th magnitude.

Professor W. W. Campbell, who is well known for his astrophysical researches, has been appointed Director of the Lick Observatory, in succession to the late Prof. J. E. Keeler.

The observations made by the members of the Variable Star Section of the B. A. A. indicate that the observed phases of Beta Lyræ fall a little later than the calculated phases as published in the *Companion to the Observatory*, the difference being perhaps 1·4 days.

The preliminary reports of the British official parties who observed the solar eclipse last May have recently been issued by the Royal and Royal Astronomical Societies. They show that although perhaps no striking discoveries were made, a vast number of valuable records of the phenomena were secured. Mr. Newall attaches some importance to the fact that the moon was darker than the sky, thus suggesting that some of the light usually attributed to the sky comes from beyond the moon. Mr. Evershed concludes that the "flash" spectrum is as constant a feature as the Fraunhofer spectrum itself.—A. F.

ENTOMOLOGICAL.—Some interesting observations on the growth and development of instinct in spiders have been recently published by Miss A. B. Sargent (*Proc. Acad. Nat. Sci., Philadelphia*, 1900, pp. 395–414). The species studied were a large orb-weaving spider *Argiope*, and the common long-legged tube-weaving spider of North America, *Agelena nævia*. (Our British *A. labyrinthica* is well-known to arachnologists.) Almost all mother spiders surround their eggs with a silken cocoon, in which the young spend the first few weeks of their lives after hatching. Miss Sargent concludes that the main object of this cocoon is to prevent evaporation of moisture from the young spiders, and that it serves in a less degree as a protection against enemies, such as wasps and ichneumon-flies. The young spiders were kept under observation through the winter, and it was found that they could endure a large amount of cold and damp, but that warm dry surroundings killed them. When associated together in the cocoon the young Argiope were always found to rest with the ventral surface outwards, perhaps to facilitate respiration by presenting the breathing holes to the outer air. In the development of the senses, touch seems to be shown earliest, and light and darkness are distinguished before the form of objects can be made out. The earliest "psychical" manifestations made by the young spiders were interpreted as indicating fear. While still in their "little nests," young spiders seem to live harmoniously together, but the individuals of an Agelena family were eager to eat one another when they had begun to make their own way in the world.—G. H. C.

Zoological.—The micro-organism of distemper in the dog is described by Mr. M. C. Potter in the *Proceedings* of the Royal Society. It is shown that a culture can readily be produced, which there is good hope will lead to a very considerable mitigation of the disease in question.

For several years Herr G. Tornier has been studying examples of lizards, newts, and frogs with double tails or additional limbs, and has shown (*Zool. Anzeiger*, 1897-98) how such abnormalities can be produced artificially. In his most recent contribution to the subject (*Ibid.*, 1900, No. 614) he figures several newts showing various types of bifid tail, and describes in detail the manner in which regeneration of the tail produces such abnormalities.

Mr Walter Rothschild's long-expected monograph of the cassowaries, together with Mr. W. P. Pycraft's dissertation on the structure and relationships of the ostrich-like birds, has just been published in the *Transactions* of the Zoological Society, illustrated by no less than eighteen coloured plates. It is a magnificent piece of work, admirably carried out from first to last. Eight species of cassowaries, which naturally fall into three groups, are recognised, several of them being divisible into a larger or smaller number of local races. Morphologists will, of course, be most interested in Mr Pycraft's communication. In his opinion, the Ratitæ (or, as he prefers to call them, Palæognathæ) have diverged in several separate branches from points very low down in the avian stem, which is continued upwards to split up into the various groups of Carinatæ (Neognathæ). It is, however, difficult to realise how these birds became flightless comparatively so soon after the acquisition of wings by the class in general. And it is still less easy to understand how the Ratitæ can be so much older than the cretaceous Carinates of the United States as the author considers to be the case. All the available palæontological evidence (especially as Mr. Pycraft excludes the eocene *Gastornis* and *Diatryma* from the Ratite group) points exactly in the opposite direction.

The attention of all interested in the molluscs and brachiopods of the British seas should be directed to a classified list of species drawn up by a committee of experts and published in the January number of the *Journal of Conchology*. The nomenclature appears to have been revised with great care, and it may be hoped that its publication will tend to promote uniformity in this respect among conchologists.

A most interesting exhibit is now on view in the Central Hall of the Natural History Museum. It consists of a wax model of the African tsetse fly, enlarged to the dimensions of a big bat. Alongside are models of red blood-corpuscles, enlarged to the dimensions of medium-sized biscuits, and between them two models, on a similar scale, of the tsetse parasite. The whole exhibit is beautifully executed and most instructive.

According to the investigations of Miss Lee, of which an abstract appears in a recent issue of the *Proceedings* of the Royal Society, the skull-capacity of a large number of individuals does not tend to support the theory that relative brain-weight either in the individual or in the sex, is associated with relative intellectual power. It is stated that "one of the most distinguished of Continental anthropologists has less skull-capacity than 50 per cent. of the women students of Bedford College; one of our leading English anatomists less than 25 per cent. of the same students."

Notices of Books.

"By Land and Sky." By the Rev. John M. Bacon, M.A., F.R.A.S. (Isbister & Co.) Illustrated. 7s. 6d.—Mr. Bacon's book will probably be read more for its living interest and spirit of adventure than for its scientific qualities. His narratives of balloon ascents by others and himself, and his descriptions of observations made under these and other conditions, possess the personal and general characteristics appreciated by a large public. We hasten to add that the book also contains many original observations on the transmission of sound, and revises some of the views on that subject usually found in text-books. Take, for instance, the belief that clouds can produce echoes. Mr. Bacon says that he has "never obtained an echo from a cloud, either from a hollow of such cloud, from the under surface of a cloud canopy, or from the upper surface of a cloud floor." No sky or cloud echoes were observed by him even under the most favourable conditions. Some remarkable observations in the whispering gallery of St. Paul's are described, and they seem to dispose of the theory that reflection from the opposite parts of the dome is the sole cause of the phenomenon exhibited by the gallery. The suggestion is made that the sound waves travel around the wall "as a ball hugs the circular end of a bagatelle board," but this analogue will not commend itself to the mind of a physicist. Incidentally, attention is called to the fact that instead of going to a window to listen to a distant sound, it is often better to open the casement and to retire back into the room. As to the action of fog upon sound, Mr. Bacon holds that though a uniform quiescent fog may offer no obstruction to sound, rolling masses of fog of varying temperature and density may impede sound waves, or even reflect them. In one of his essays, Mr. Bacon throws doubt on the statement that the sound of a bursting meteor has been heard on earth, and suggests that when such a report has been heard it probably had a terrestrial origin. We believe that no shooting-stars have ever been accompanied by explosive sounds, but surely there is ample evidence that actual meteorites and fireballs have been heard to explode. Mr. Bacon gives the impression that all meteor sounds are illusions.

"Design in Nature's Story." By Dr. W. Kidd. (Nisbet.) 3s. 6d. net.—In these days, when we hear so much of the evolution of animal organs and structures according to an assumed "adaptation" to inanimate surroundings, and of the origin of horns and antlers from the bruises produced on their heads by contests between the males of the ox and deer tribe, it is distinctly refreshing to find that there is a writer left among us who has the courage to plead for the older conception of "design" in nature, and for the direct supervision of a personal Deity over the evolution of the animal life of our globe. Whether the author has succeeded or not in proving his contention, we may well leave our readers to judge for themselves, and we will therefore be content with quoting his concluding paragraphs. After referring to the fact that plants alone extract nutriment from the soil, and that animals live upon the present or past life of plants, Dr. Kidd proceeds as follows:—"It were wearisome to elaborate this well-known fact of nature. The simple fact remains, and no scientific explanations of the 'natural' laws under which it takes place touch for an instant its striking value as a broad argument for Design in Nature. . . . The objections of Darwin, Romanes, and Milnes Marshall, by the very earnestness of the challenge, and the magnitude of the answer afforded by the whole vegetable kingdom, constitute a body of evidence against the blind mechanical force which they deify of obvious cogency."

"A Year with Nature." By W. Percival Westell. (Drane.) Illustrated. 10s. 6d.—Under this title the author has perpetuated, between handsome covers, and in an expensive form, a series of observations of nature referable to each month of the year, and previously published in various journals. We can discover no permanent value, or indeed interest in these papers, neither is there anything original in them. Indeed, Mr. Westell's observations are little more than a series of platitudes badly strung together, and it seems a pity that they were not allowed to remain in the comparative oblivion from which they have been dragged. As far as the author's qualifications for writing are concerned we judge him by his own words, for he has "not tried to cultivate any literary style," and in his opinion, the "rush and tear of present-day life only allows us to sip, rather than drink, at nature's sweet fountain."

"W[illegible]." By F. H[illegible]. (Chapman & Hall.) Illustrated. 6s.—No useful purpose would be served by a descriptive or critical notice of this book. The author has peculiar ideas upon some classes of natural phenomena, and he announces established truths as if they were original discoveries. We have not for some time seen a book to which the remark could be more appropriately applied that "What is new in it is not true, and what is true is not new."

"The Story of Nineteenth Century Science." By H. S. Williams, M.D. (Harper Bros.) Illustrated. [illegible]s.—Dr. Williams is not omniscient, but he has managed to survey the field of modern science in a very creditable manner. So far as we are aware, no other single volume exists in which such a bright and connected account of the scientific progress of a century is satisfactorily dealt with in reasonable limits, and we are glad to give Dr. Williams credit for making this available. Practically every branch of natural knowledge is passed in review in separate chapters, and though the book has an American origin, there is little evidence of a more than natural tendency to attach undue importance to work done on the other side of the Atlantic. The author appears to have exercised a wise discretion in the selection of material, and to be able to weigh justly the value of the results obtained by various observers, and in different countries. He has the eye for broad principles and suggestive generalisations essential for the preparation of a successful book of this kind. The last chapter, on "Some Unsolved Scientific Problems" is a view of questions in physics and biology in the light of the results described in earlier parts of the book, and it suitably terminates the story. From internal evidence we conclude that some parts of the book were not written very recently, but we are content to let this pass. The titles of the reproductions of star clusters on pages 71 and 81, need revision, and the picture of star spectra, on page 73, does not show a single spectrum line. The pictures of clouds are also not worthy of the text, that of stratus clouds being very bad. Notwithstanding these minor imperfections, the book is one to be purchased by everyone who desires to become acquainted with the main lines of scientific progress in the past century.

BOOKS RECEIVED.

Matriculation Directory. No. XXIX. January, 1901. (The University Tutorial Series.) (Cambridge: Burlington House.) 1s.

Report of the Hampstead Scientific Society, 1899–1900. 3d.

The Pianist's A B C Primer and Guide. By W. H. Webbe. (London: Forsyth Brothers.) 6s. net.

Michael Faraday: His Life and Work. (The Century Science Series.) By Silvanus P. Thompson, D.Sc., F.R.S. (Cassell.) [illegible]

Transactions of the Royal Scottish Arboricultural Society. Vol. XVI. Part II. (Edinburgh: Douglas & Foulis.)

Debrett's House of Commons and the Judicial Bench, 1901. (Dean.)

The Complete Works of John Keats. Vol. III. Edited by H. Buxton Forman. (Glasgow: Gowans & Gray.) 1s. net.

The Self-Educator in German. (Self-Educator Series.) Edited by John Adams, M.A., B.Sc. (Hodder & Stoughton.) 2s. 6d.

Deschanel's Natural Philosophy. Part III.—Electricity. By J. D. Everett, M.A., D.C.L., F.R.S. (Blackie.) Illustrated. 4s. 6d.

The Self-Educator in Chemistry. (Self-Educator Series.) By James Knight, M.A., B.Sc., [illegible] (Hodder & Stoughton.) 2s. 6d.

Museums Association. Report of the Proceedings, 1900. Edited by E. Howarth, F.R.A.S., F.Z.S. [illegible]

Advanced Exercises in Practical Physics. By Arthur Schuster, PH.D., F.R.S., and Charles H. Lees, D.Sc. (Cambridge: University Press. London: Clay.) Illustrated.

An Introduction to Modern Scientific Chemistry. By Dr. Lassar-Cohn. (Grevel.) Illustrated.

Zoological Results [illegible]. By Arthur Willey, D.Sc. LOND., HON. M.A. [illegible] Part V. (Cambridge University Press.) Illustrated. 21s.

Return 1900 County Council [illegible]. [illegible]

Symons's Meteorological Magazine. February, 1901. (Stanford.) 4d.

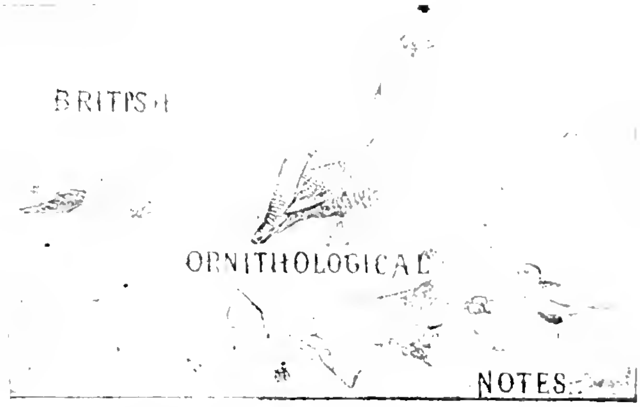
The Studio. Vol. 22. No. 95. February 15th, 1901. [illegible] 1s.

Differential and Integral Calculus for Beginners. By E. [illegible] Edser, A.R.C.S., F.PH.S. (Nelson.) 2s. 6d.

The Journal of the Society of Comparative Legislation. [illegible] 1900. Edited by John Macdonell, LL.D., and Edward Manson. (Murray.) 5s. net.

The Cambrian Natural Observer. Edited by [illegible] February, 1901. (Annual subs. 2s. 6d.)

A Manual of Elementary Science. By R. A. Gregory, F.R.A.S., and A. T. Simmons, B.Sc. LOND. (Macmillan.) Illustrated. [illegible]



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

The Migration of the Song Thrush.—Referring to the note in Knowledge for January, on the "Migrations of the Song Thrush," I am able by recent observation to confirm one statement made there, viz.: "In the winter (from October to February) we have a different kind of migration. These movements are entirely due to outbursts of cold or bad weather." During the evening and night of January 8th one of these outbursts of cold weather took place, and the next morning the whole country hereabout was covered with snow. During the morning, and lasting for about two hours, I witnessed the largest migration of Thrushes that I have ever seen, and I called the attention of several to the most unusual sight. The stream of Thrushes was continuous but irregular, and it passed directly over the town in the direction of the sea coast—about twenty miles distant. Some thousands of birds passed over, sometimes in single stragglers, and at others in dense flocks of hundreds.—E. Sillence, Romsey, February, 1901.

Snowy Owl in Co. Donegal (*Irish Naturalist*, February, 1901, p. 50).—Mr. Robert Patterson records that a female Snowy Owl (*Nyctea scandiaca*) was shot on December 15th last by Mr. John Olphert's keeper, at Bally-Connell House, Falcarragh. The remains of a rabbit were in the bird's stomach. The Snowy Owl is a rare and uncertain visitor to Ireland.

King-Eider in Co. Down (*Irish Naturalist*, February, 1901, p. 50).—Mr. Patterson also records that on November 10th, 1897, a mature male King-Eider (*Somateria spectabilis*) was shot in the Foreland Bay, off Donaghadee, by Mr. Wm. H. Shaw. The King-Eider is a very rare winter visitor to Ireland. We believe that this is the first adult male that has been recorded.

A Young Cuckoo on Migration (*Irish Naturalist*, February, 1901, p. 50).—Mr. Richard M. Barrington's systematic investigations into the records made at his instigation by Irish lighthouse keepers of the birds which strike the lanterns, have produced many valuable and interesting results. The latest find he records here. The leg and wing of a young Cuckoo have been sent to him from the Skulmartin Lightship, Co. Down. The bird was killed by striking the light on November 26th, 1900. Young Cuckoos sometimes remain here until October, and one was killed at the Tuskar Light, off the west of Ireland, on November 2nd, 1883; but November 26th is previously [illegible] date. It is probable that the bird was bred somewhere [illegible] high north.

Grey Phalarope in Lincolnshire (*The Naturalist*, February, 1901, p. 42).—Mr. J. Conway Walter records that a bird of this species was shot near Kirton-in-Boston on November 9th, 1900. The Grey Phalarope is a rather irregular visitor to Great Britain, and when it does visit us is extremely rarely [illegible] England north of Norfolk.

Long-eared Owls as Anglers (*The Naturalist*, February, 1901, p. 42).—Mr. Max Peacock describes [illegible] fishing [illegible] by Long-eared Owls [illegible] some time ago [illegible] at Bottesford, [illegible] A pair of these Owls had [illegible] in a fir tree near a mill [illegible] when the waters [illegible] stopped [illegible] Owls began [illegible] in turn swooped down [illegible] water [illegible] captured a fish—[illegible] some [illegible] 5 inches in length—[illegible] with it to the fir tree.

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.*

FINGER-PRINTS AS EVIDENCES OF PERSONAL IDENTITY.

By R. Lydekker.

In the gradual and imperceptible transition from childhood to old age almost all parts of the human frame are subject to a certain amount of alteration, either in form or in structure, so that it is matter of extreme difficulty to find any one feature by which an individual may be distinguished with absolute certainty from among all his fellow men. A remarkable exception to this tendency to change is, however, exhibited by the minute ridges and grooves on the balls of the fingers, which, as explained in the article on "Monkey Hand-Prints," are arranged in a number of minute concentric lines forming characteristic patterns. In all monkeys, with the exception of some of the man-like apes, the patterns formed by these papillary ridges, as they are termed, are of a comparatively simple type. The patterns of monkey finger-tips are indeed arranged in simple flexures, which come under the denomination either of "loops" or "arches," according to the classification employed in the deciphering of human finger-prints. Such a "loop" is shown in Fig. 1, which

Fig. 1.—Impression of Middle Human Finger, displaying the looped arrangement of the papillary ridges.

represents the impression of the middle finger of a human hand. In an "arch" the flexure is still simpler, and does not exhibit that marked inclination to one side or the other which forms such a characteristic feature in loops.

In a large number of human fingers a still more complex type of flexure is observable in the ridges, which

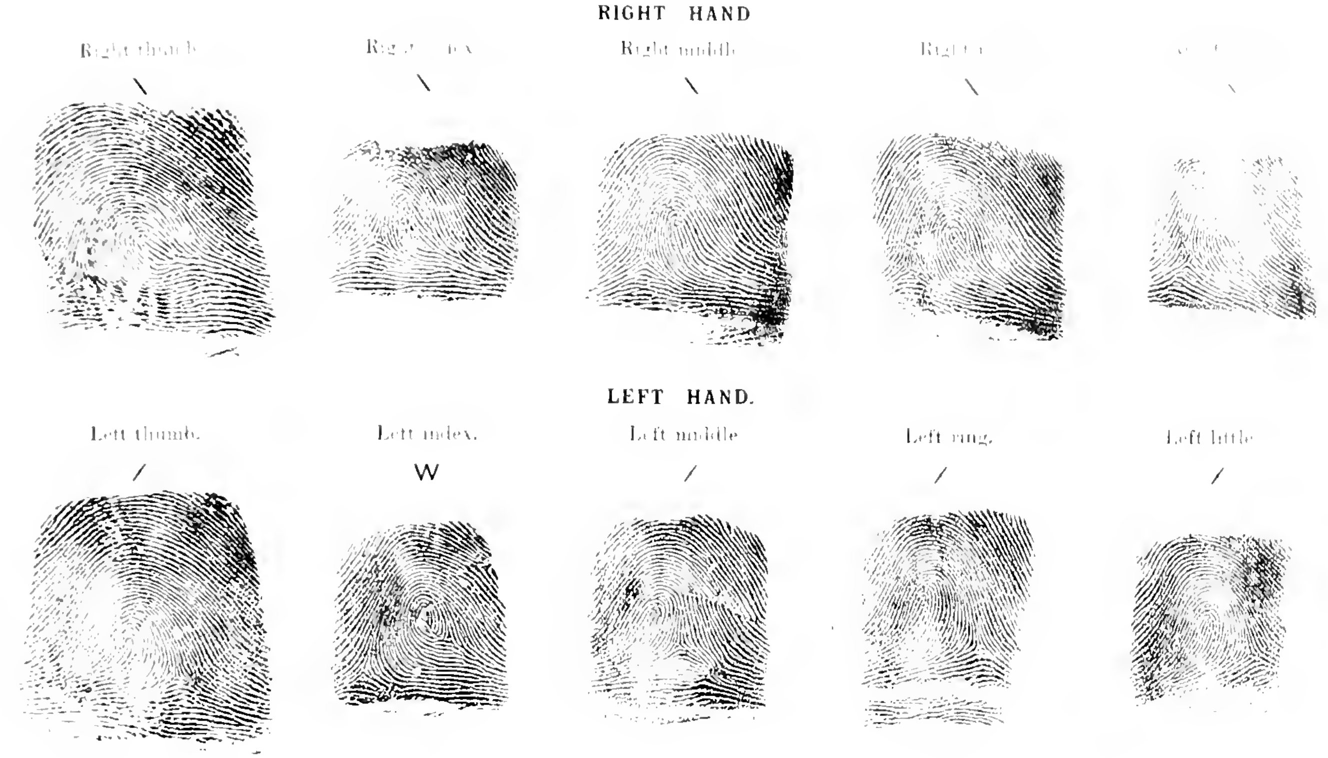
Fig. 2.—Impression of Fore, Middle, and Ring Fingers of a Right Human Hand.

assume a kind of vortex arrangement around a central nucleus. This type is denominated a "whorl," and is beautifully displayed in Fig. 2, which shows the prints made by the fore, middle, and ring fingers of a right human hand. Still more complicated patterns may be produced by the mingling of two whorls, or of a whorl and a loop, or a whorl and arch in the same finger; such types being designated as "composites." Whorls and composites being obviously more complex than loops and arches, it is interesting to note that they are unknown in ordinary monkeys; and the gradual progression in complexity of pattern from these latter through the man-like apes to man himself is just what would have been expected to occur if the doctrine of evolution be true. It has not yet been ascertained whether the presence of arches and loops is more common in the finger-tips of the lower races of mankind, while whorls and composites are relatively more numerous among nations of higher cultivation, but it is possible that this may eventually prove to be the case. As the result of the examination of the finger-tip impressions of a very large number of Europeans and natives of India, it appears that about five per cent. come under the denomination of arches, while sixty per cent. are loops, and thirty-five per cent. whorls and composites; the proportion of each varying considerably in the several digits. For the purposes of forming a classification of finger-prints, arches, being so few, may be reckoned as loops, while composites may be included in whorls, thus giving only two types to deal with.

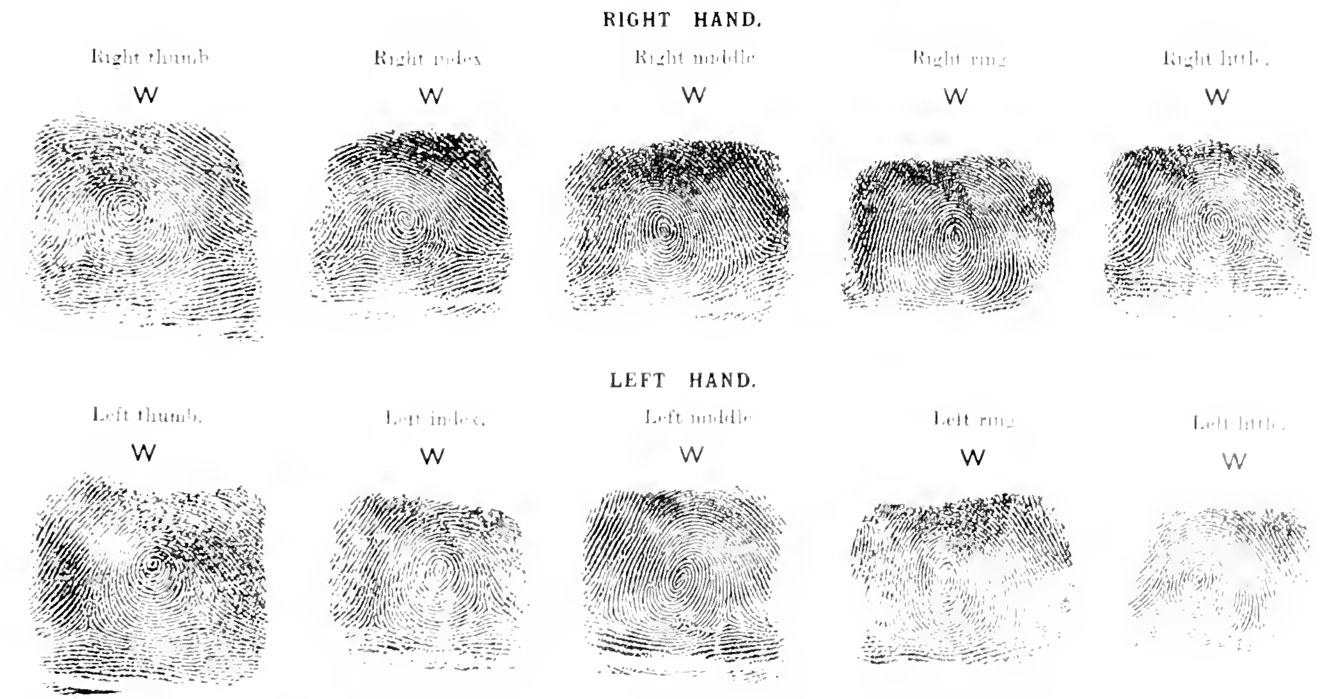
But before going further a few words are advisable as to the manner in which finger-prints are taken. The fingers are first pressed on a plate of tin which has been evenly and thinly coated with printing ink, and may be then pressed on suitable paper in such a manner as may be thought desirable, when, if due precautions to avoid smudging are taken, clear prints similar to the originals from which the accompanying figures were reproduced will be obtained. When the tips of the fingers are merely pressed on the paper without any other movement, the print is termed a plain one, as in Figs. 1 and 2; and it is manifest that when (as in the case of the latter) the impression of three or more figures is taken simultaneously it must be of this nature. But such a print displays only the central portion of the pattern of each finger; and in order to obtain the pattern of a larger area of the finger-tip recourse is had to another plan. To take a rolled impression, as it is called, one finger only is inked at a time, and when coated with ink is laid on the paper in such a position that the nail is in a vertical plane, after which it is rolled on the paper across the ball till the nail is again vertical. Two complete series of such rolled impressions are exhibited in Figs. A and B. It will be seen that they are taken in the natural order, commencing with the right hand, and passing from the thumb to the little finger; and then repeating the process with the left hand, the impressions from which are placed below those of the corresponding digits of the right hand. Of course such impressions are always taken in the presence of a responsible officer; but to prevent the possibility of fraud, "plain" impressions of the fore, middle, and ring fingers of each hand are taken at the same time on the same sheet as the "rolled" impression. As an additional precaution, the three fingers in question are thrust through a frame having three apertures before they are inked, and the impression is taken while they are thus fixed. The three plain impressions shown in Fig. 2 are those of the three central fingers of the right hand of the individual marked B (see figures), and they will be seen to correspond exactly with the middle portions of the rolled impression. Such correspondence is quite sufficient to indicate that the rolled impressions have been taken in their proper sequence and belong to the same individual.

For the purpose of identifying individuals by means of their rolled finger-joints, arranged in the foregoing order,

A. Classification No. $\frac{1}{3}\ \frac{U}{O}$.



B.—Classification No. $\frac{32}{32}\ \frac{I\ I}{O\ M}$



an ingenious scheme has been invented by Mr. E. R. Henry, Chief Commissioner of Police in Bengal.

Those impressions showing whorls (or composites) are marked with the letter W. Loops, on the contrary, are indicated by oblique lines sloping in the direction taken by the loop itself. When for example, the palm of the right hand being on a table, the downward slope of the ridges forming the loop is from the thumb towards the little finger, the slope is said to be ulnar, on account of running towards the ulna, or larger bone of the fore-arm. In the right hand of individual A (see figures) all the slopes are ulnar. When the loops in the right hand take the opposite direction, that is to say when they incline from the little finger towards the thumb, they are said to be radial, on account of pointing towards the radius, or smaller bone of the fore-arm. It will be obvious that the direction of ulnar and radial slopes will be the reverse in the left hand of what it is in the right; consequently all the loops in the left hand of individual A will likewise be ulnar. Hence the individual in question shows no radial loop at all.

In the formula adopted for the division of finger-prints into primary groups, all loops, whatever their direction (as well as arches), are indicated by the letter L. The digits are then taken in pairs as follows, viz.:

$$\frac{\text{Right thumb.}}{\text{Right index.}} \quad \frac{\text{Right middle.}}{\text{Right ring.}} \quad \frac{\text{Right little.}}{\text{Left thumb.}} \quad \frac{\text{Left index.}}{\text{Left middle.}} \quad \frac{\text{Left ring.}}{\text{Left little.}}$$

And the letter L or W substituted for the names of the fingers themselves, according as their respective impressions show loops or whorls. Following this arrangement, the formula of the finger-prints made by individual A will be

$$\frac{L}{L} \quad \frac{L}{L} \quad \frac{L}{L} \quad \frac{W}{L} \quad \frac{L}{L}$$

In individual B, on the contrary, the formula will be

$$\frac{W}{W} \quad \frac{W}{W} \quad \frac{W}{W} \quad \frac{W}{W} \quad \frac{W}{W}$$

This, however, does not help much in making a workable scheme of classification, and the following plan has consequently been proposed. Whenever a whorl (W) occurs in the first of the five pairs, it is allowed to count as 16; if it occurs in the second pair its value is 8; if in the third pair 4, if in the fourth 2, and if in the fifth 1. Consequently the numerical value of individual A will be

$$\frac{0}{0} \quad \frac{0}{0} - \frac{0}{0} \quad \frac{2}{0} \quad \frac{0}{0} - \frac{2}{0}$$

while that of individual B will work out as

$$\frac{16}{16} \quad \frac{8}{8} \quad \frac{4}{4} \quad \frac{2}{2} - \frac{1}{1} = \frac{31}{31}$$

To each value thus attained $\frac{1}{1}$ is added, and the fraction* being inverted, what is known as the primary classification number is obtained. Accordingly, in individual A we have $\frac{2}{0} + \frac{1}{1} = \frac{3}{1}$, and by inversion $= \frac{1}{3}$; while in B we have $\frac{31}{31} + \frac{1}{1} = \frac{32}{32}$.

It will be obvious that individual B presents the highest possible formula, every one of the digits exhibiting a whorl. Individual A, on the contrary, displays very nearly the lowest possible formula, which would occur when there were loops in every digit, in which case the formula would be $\frac{0}{0} + \frac{1}{1} = \frac{1}{1}$.

Consequently all possible combinations of loops and whorls may be indicated by formulæ varying in value between a minimum of $\frac{1}{1}$ and a maximum of $\frac{32}{32}$.

* Although, of course, not really a fraction, it is sometimes convenient to speak of the value as such.

But in the first pair of digits the number of combinations of loops and whorls that it is possible to have are four, that is to say we may have any one of the following four values, viz: $\frac{L}{L}$, $\frac{L}{W}$, $\frac{W}{L}$, or $\frac{W}{W}$. And since (to paraphrase from Mr. Henry's book on finger-prints) the same number of combinations occur in the second pair of digits, and as each of these may be combined with each and every arrangement obtaining in the first pair, the total number of possible combinations in these two is sixteen. But the third pair of digits has likewise four possible arrangements, which, taken with those of the first and second pairs, raise the number to 64. By adding the combinations to the fourth pair, the number rises to 2256, and with the inclusion of the fifth pair to 1024, which is the square of 32. Consequently a square cabinet containing 32 tiers of 32 compartments each will suffice for the accommodation of all the groups into which finger-prints are divisible according to the primary classification.

But it is obvious that there may be a very large number of individuals in whom the patterns on the fingers are expressed by the formula $\frac{1}{3}$ or $\frac{32}{32}$; and as a matter of fact the largest accumulations do occur in the case where there are either all loops $\left(\frac{1}{1}\right)$ or all whorls $\left(\frac{32}{32}\right)$. Consequently sub-divisions of these great groups are essential. And a secondary classification has been invented, depending, in the case of the lower values, on the occurrence of arches or in the direction of the loops in certain digits, or, in the case of the higher values, on the manner in which the individual lines are arranged in the whorls or composites. To enter in detail into this secondary classification would be quite out of place, and those who would study the subject seriously must consult Mr. Henry's book.

In the lower values attention is paid to the circumstance whether the index fingers show an arch, a radial, or an ulnar loop, or, when they have a whorl, as to the arrangement of the central lines. In cases where whorls are absent, and the formula is consequently $\frac{1}{1}$, both index fingers may show an arch, when the formula will be $\frac{1}{1}, \frac{A}{A}$, or a radial loop, when it will be $\frac{1}{1}, \frac{R}{R}$, or an ulnar loop, when it will be expressed as $\frac{1}{1}, \frac{R}{R}$. And there may, of course, be any combinations of these, such as $\frac{1}{1}, \frac{A}{R}$. In the individual indicated as A, in the figure, whose primary formula is $\frac{1}{3}$, it will be seen that the right index has an ulnar slope; while in what are known as the deltas of the whorl in the left index, a certain line takes a course external to another, and is consequently classed as outer, with the symbol O. The full classification formula of individual A will therefore be $\frac{1}{3} - \frac{U}{O}$.

Turning to individual B, the characteristic delta-line in the right index is internal, while in the left index it is external or outer, this being indicated by the symbol $\frac{I}{O}$. Again, in the right middle finger the distinctive delta-line is internal, while in the corresponding digit of the left hand it is median in position, this being expressed as $\frac{I}{M}$. Consequently the complete classification number for individual B will be $\frac{32}{32} \; \frac{\text{I. I.}}{\text{O. M.}}$

It will thus be seen that by paying attention to minute points, the larger accumulations of sheets may be broken up into such a number of minor groups that there will be little difficulty in assigning to its proper serial position each new record that is added, or in identifying duplicate impressions of the same individual. When the classification numbers of any two or more sheets agree, even as regarding the letters denoting the secondary characteristics, they may be differentiated by comparing together (with the aid of a lens) the prints of each individual finger, where a number of minute but characteristic peculiarities will be sure to be detected, which will serve to distinguish the two records.

The method of the identification of individuals by means of this ingenious system is, of course, perfectly simple. Where it is in use, as in India, the finger-prints of every individual who is convicted in the law courts are taken and duly pigeon-holed or filed, according to the classification described above. When any individual, previously unknown to the police of the district, is charged with an offence, his finger-prints are immediately taken and duly classified. Reference is then made to the corresponding group of classification-numbers in the cabinet or file, and if an absolutely identical impression is found, the whole history of the individual is at once made known. If the duplicate of his impression is not in the series, it is evident that the accused is "unknown to the police," and he is therefore entitled to the benefit of the "First Offenders' Act," or its Indian equivalent.

But this is not all. Occasionally a burglar, by cutting his hand, or by smearing it with ink or some other substance, may leave the impression of one or more of his fingers on some article in the house. And Mr. Henry, in a paper read before the British Association at Dover in 1900 (to which we are indebted for the information embodied in this article), gives an instance of this nature which led to the identification and conviction of the criminal. Briefly stated, the case was as follows:—The manager of a tea estate in the Julparguri district was found foully murdered, his despatch box, in a rifled condition, lying near the body. In this box was an almanack marked with two faint brown smudges. By chemical examination these were proved to be made by human blood, while, by the aid of a magnifying-glass, one of them was discovered to be the print of a human thumb, which was subsequently identified as that of a certain individual whose finger-record had been filed by the Bengal police. The evidence was considered by a native jury sufficient to convict the accused of theft, although (somewhat inconsequentially) not of murder, and he was accordingly sentenced to a term of imprisonment.

Other systems of classification of finger-prints have been prepared, but, in our opinion, none are equal in simplicity and convenience to that invented by Mr. Henry. As already said, it has been adopted in India, and it might, we think, be advantageously used in this country.

In addition to their value as a means whereby suspected persons may be readily and indisputably identified, finger-prints have, however, as already indicated, a very considerable degree of interest to the naturalist. They serve to show that even in such minute details as the arrangement of the ridges on the skin of his finger-tips man has attained a higher degree of specialisation than the lower monkeys, and that certain of the man-like apes alone approximate to him in this respect. The subject is, however, still in its infancy, and further interesting results will doubtless accrue from a more extended investigation, one of the points to determine being, as already indicated, whether "whorls" are more predominant on the finger-tips of the higher as compared with the lower races of mankind.

Conducted by M. I. Cross.

British versus Continental Microscopes.—For accurate original research, where the worker has some understanding of the mechanical and optical means at his disposal, there is no microscope in the world to be compared with the best of those produced by the leading British houses. In them are to be found refinements of mechanical skill which, suitably employed, call forth a response from objectives and condensers which causes them to yield their very best effects. Even in the British models of medium size and at modest cost there are to be found several that are but slightly less effective than the largest, and with which no Continental stand can vie.

Yet the British microscope plays but an insignificant part, numerically, in the world's supply. In laboratories and in places where microscopes are largely used, the Continental instrument holds sway and seems likely to maintain it, at any rate for the present. The question of price is not the factor in the existing state of things, for even in student's stands the British manufacturer keeps his rates at the competitive mark. Why then is it that he does not receive a larger share of appreciation and support?

The reasons usually given appear to be two in number, and are—

1. The British microscope exceeds the needs of the laboratory worker and student:

2. The casing and general "fit up" is inferior.

The first is distinctly a laboratory cry, and may be regarded as due to want of appreciation and education in matters microscopical. The second is more general in its application and in a lesser degree influential.

To do the largest amount of work in the least possible time with the most cut and dried materials is a spirit which pervades the present day, and it applies to microscopical as much as to other spheres of activity.

The laboratory worker wants as much done for him as possible, so that it may only be necessary for him to place his object on the stage and "spot" the structure. To get the best from lenses and condenser is not in his province. "Numerical aperture," "aplanatic cone," and "critical image" are, as a rule, vague terms to him. Hence it comes that an instrument that always has its substage condenser approximately focussed and centred, and the mirror fixed in the line of the optical axis, saves him time and bother and suits his methods of working.

No one can defend the use of what are in reality but rough and ready means of examination of structure, and no reliance can be placed on deductions made from such methods. We are among those who are sanguine enough to hope that in the no very distant future, the advantage of perfect control in manipulation, and a rigid tripod foot, as provided in the majority of British microscopes, will supersede the Continental model.

This can only be brought about by a demand for more thorough teaching of microscopical principles and manipulation, and if good work is to be done in English laboratories it should be seen to that those who use the instruments shall get the best possible out of them. If this necessity were recognised and taken up vigorously by the scientific world—and many know full well how much it is needed—a different state of things would in time prevail. We would not advocate the pandering to a low degree of appreciation by reducing either the calibre or working accuracies of the instrument. Let us all do our best to raise the users to a higher level.

Meanwhile, the British manufacturer has opportunities of making his instruments more acceptable in several ways, and especially in the casing and general "fit up."

A great improvement has taken place in recent years, but there is yet room for further effort. Generally speaking, British houses are inferior to their Continental rivals in this respect. It must be remembered that the horseshoe foot is more easily gripped and held firmly in its case than the tripod, but a strong and neat fitting for the latter ought not to be beyond the powers of the ingenious to contrive.

It may be fearlessly stated that a good day is coming yet for British microscopes if the makers do but set their house in order, and in addition to providing the most sound and accurate instrument that can be, they give due consideration to every detail which will make them acceptable to those who are influenced by appearance. There is no disgrace in making a microscope and its case ornamental as well as useful.

Staining Living Bacilli.—We have had placed in our hands an interesting paper by Mons. A. Certes dealing with the selective colouring power of the spore-bearing filaments of the *living Spirobacillus gigas* with methylene blue, and the following is a brief *résumé* of it.

He remarks that the experiments of Brandt, Henneguy and himself, dating from 1881, prove that living protoplasm can absorb certain aniline colours, but little has been done by biologists in the study of the action of colouring substances on living microbes. It has been found that certain microbes cease to live on being stained, others absorb the stain and still remain alive, while others do not absorb the stain either alive or dead.

The difficulty of making observations on selective coloration is obvious on such delicate subjects as bacteria, but M. Certes was fortunate in discovering the *Spirobacillus gigas* in the reservoirs at Aden; the length of these is usually 150—160 mikrons, but they are occasionally found 400 mikrons long.

These organisms placed in a weak solution of methylene blue continue to move about with the same activity as before, and the stained specimens can be preserved alive until the following day if care be taken not to exclude oxygen.

The effect of the stain varies according to the stage of development of the bacilli. During the first two or three days the living specimens are entirely and uniformly stained in blue exactly like dead specimens.

When the period of sporulation commences, alongside of the totally stained bacilli, the presence of bacilli of different shapes is observed, partially stained and much more clearly. In the same specimens are coloured rings in juxtaposition to uncoloured rings, grouped in the most varied manner and without any apparent fixed rule.

The spore-bearing individuals which appear a little after, give the clue to these selective coloration phenomena, which acquire a still greater clearness when the specimens are larger—as the turns of the spiral are less serrated, and the spore-bearing bacilli move more slowly in zig-zag fashion. One sees, therefore, that the spores, while refractive, have, except in rare cases, absorbed the colouring matter, and that the filaments which carry them are, in general, more feebly coloured, sometimes even uncoloured, and that in those specimens whose spores are localised at one extremity on a fixed point on the filament, the rings which carry the spores are almost always uncoloured.

Success largely depends on the colouring re-agents that are used. The finest quality of Ehrlich's blue and the chemically pure methylene blue of Grübler and Höchst in very weak solution are recommended, and they should be used at the precise moment when the first sporule-bearing individuals appear.

These phenomena are only visible in the living state; dead specimens stain so rapidly and uniformly that it is extremely difficult to obtain preparations in which the differentiated coloration is distinctly visible.

New Apparatus described by Manufacturers.—We have received from Messrs. A. E. Staley & Co., of 35, Aldermanbury, London, some very interesting notes regarding the microscopes and accessories manufactured by *The Bausch & Lomb Optical Co., Rochester, New York, U.S.A.*

It is, unfortunately, impossible to reproduce the details in their entirety, but we have much pleasure in calling attention to the fact that Messrs. Staley have been appointed agents for Great Britain for these famous instruments.

A perusal of the English edition of Messrs. Bausch & Lomb's catalogue discloses the fact that prices have been considerably modified for the English market.

Those who have a preference for the Continental type of stand will find an assortment of these of varying sizes, while microscopists who are interested in objectives and apparatus will find it well worth their while to peruse the handsome catalogue.

The Bausch and Lomb microscopes have a great reputation in the United States, and are, undoubtedly, soundly constructed, well finished, and in the English catalogue moderately priced.

W. Watson & Sons, 313, High Holborn, W.C.—A new form of sterilizable needle for blood examination, designed by Drs. Slater and Spitta. It is of metal throughout, can be sterilized, and remains so when carried in the pocket. It is self-contained, and carries a reserve of lancet-pointed needles in its recessed end

Notes and Queries.—*Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to* M. I. Cross, Knowledge *Office*, 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

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

Giacobini's Comet.—The small comet discovered at Nice, on December 20th, was very faint, and it had already passed its perihelion. Becoming fainter with increased distance from the earth it was only observed in large telescopes, and has now practically passed beyond the range of visibility. From observations between December 24th, 1900, and January 14th, 1901, Prof. Kreutz, of Kiel, finds that the comet revolves in an elliptic orbit, with a period of about 6·88 years, so that it belongs to the Jovian family. It passed through perihelion on November 28th, 1900, and the elements of its orbit bear a resemblance to those of Wolf's comet of 1884, and Barnard's comet of 1892. The comet being a periodic one of interesting character, it is to be hoped that position-observations will be secured over a sufficiently long interval to enable a good definitive orbit to be derived from them. On March 6th the place of the comet will be R.A. 4h. 7m. 53s., Dec. 10° 1′ S., so that it will be near Mira Ceti.

Brorsen's Comet.—This object ought to be fairly well visible in March, but in view of the fact that its continued existence is somewhat questionable, we cannot look forward with confidence to the re-appearance and discovery of the comet. First seen by Brorsen at Kiel on February 26th, 1846, it was found to be revolving in an elliptical orbit with a period of about 5½ years, and it was satisfactorily re-observed in 1857, 1868, 1873, and 1879, but escaped notice at the last three returns in 1885, 1890, and 1896. Should the comet elude detection during the present spring there will be no alternative but to conclude that, like the double comet of Biela, it must be numbered with the lost comets. Hind pointed out in *Ast. Nach.*, 3271, that the orbit of Brorsen's comet and of Denning's comet (I. 1894) intersect in long. 285, and that in April, 1881, the two objects must have been close to one another near the point of intersection. He was led to the conjecture that Brorsen's comet, on its recession from perihelion after it was last observed in 1879, may have met with a catastrophe, bringing about its disintegration and causing one portion of it to return in the aspect and orbit of Denning's comet of 1894. Dr. Schulhof supported these conclusions, and pointed out (*Ast. Nach.*, 3276) that the point of intersection of the two orbits coincides with the place of their nearest approach to the planet Jupiter. Dr. Lamp has also examined this interesting question, and found that the two comets passed through the corresponding points of their orbits on January 17th and January 23rd, 1881, respectively. The least distance between the two orbits was 199 radii of the earth. There is very little doubt therefore that a close conjunction of the two comets occurred early in 1881, but whether or not this indicates the actual disintegration of Brorsen's comet on that occasion is open to question. The approach of the two bodies may have been quite accidental. In any case, the re-detection either of Brorsen's comet of 1846 or of Denning's comet of 1894 will be important, as affording materials for the further investigation of the idea of their connection.

Daylight Fireball of January 6th.—This object, which appeared in bright sunshine, 52 minutes after noon, was quite of an exceptional character. It was observed by several persons in Glasgow. "T. H." says he was walking along Great Western Road a few minutes before 1 p.m. when the meteor flashed across the north-western sky. "L. D." describes the object as bursting like a ball of fire among the hedges near the Catholic cemetery as observed from Lambhill Road. Another writer noticed it from Whiteinch Park, and states that its flight was in the direction from N.E. to W. It was not like an ordinary falling star, but resembled a rocket with a long streaming tail. It apparently exploded on Scotstownhill. As seen from Rosneath the meteor appeared as a ball of fire with a tail. It darted between the trees in a westerly direction about 20 feet off the ground. At Crossmyloof it looked like a rocket flying in a north-westerly direction. It was of considerable size, the glowing mass forming the head being as large as a bowling ball with a fiery tail attached. At Durisdeer, Dumfries, "J. W. W." refers to the meteor as a large silver ball, with a long tail, appearing in a north-westerly direction. At Craighat, Killearn, N.B., the object vanished 12° above

W. N. W. [illegible] a path [illegible] 20° [illegible] 25° [illegible] N. W. The path was slightly descending, the altitude being about 5° less at the [illegible]. The brilliancy of the object was estimated three times that of Venus [illegible] best, and the [illegible] a luminous trail 18 in length.

Recent Fireballs.—Brilliant meteors of this class have been reported on following dates:—

		H. M.	
January	10	7 18 a.m.	Penshurst, Kent.
	13	10 44 p.m.	Beaminster, Dorset, and London.
	24	6 55 p.m.	Edinburgh.
	28	9 22 p.m.	Dumfries and Edinburgh.
	29	7 30 a.m.	Bristol.
February	7	8 4 p.m.	Felixstowe.
	12	7 40 p.m.	Llanelly.

Further descriptions of the observed paths of these bodies would be interesting.

January Meteoric Shower, 1901.—The prevalence of moonlight and cloudy weather has probably enabled the meteors of January 2–3 to elude observation this year. Nothing of them was seen at Bristol, and no reports have been received of successful observations elsewhere.

THE FACE OF THE SKY FOR MARCH.

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

The Sun.—On the 1st the sun rises at 6.49 A.M., and sets at 5.37 P.M.; on the 31st he rises at 5.41 A.M., and sets at 6.28 P.M. The sun enters Aries, and Spring commences on the 21st at 7 A.M. Few sunspots are to be expected. During this month the Zodiacal Light is favourably placed for observation in the western sky after sunset.

The Moon.—The moon will be full on the 5th at 8.4 A.M., will enter last quarter on the 13th at 1.6 P.M., will be new on the 20th at 12.53 P.M., and will enter last quarter on the 27th at 1.30 A.M. The following are among the more interesting occultations which occur 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.
Mar. 2	κ Cancri	[illegible]	10.46 P.M.	122	116	12.[illegible]	289	267	11 21
,, 24	ω Tauri	5.8	7.37 P.M.	89	49	8.30	268	237	4 7
,, 25	1 Tauri	5.5	6.32 P.M.	84	58	7.12	282	245	5 6
,, 26	68 Orionis	5.6	9.1[illegible] P.M.	63	24	10.6	310	278	6 9
,, 28	1 Cancri	5.9	6.16 P.M.	34	53	6.40	330	12	8 5
,, 29	A Cancri	5.8	5.30 P.M.	142	174	6.33	256	278	9 5

The Planets.—Mercury is in inferior conjunction on the 7th, and will afterwards be a morning star, but unfavourably placed for observation in our latitudes.

Venus remains a morning star, but too near the sun for naked-eye observations. She is approaching superior conjunction.

Mars can be observed throughout the night, his path being a westerly one through Leo to the north of Regulus. He crosses the meridian on the 1st at 11.38 P.M., and on the 31st at 9.12 P.M., the apparent diameter on these dates being respectively 13″.8 and 11″.6. The phase is of course almost inappreciable, the illuminated part of the disc on the 15th being 0.979.

Jupiter can only be observed in the morning, rising about 4.5 A.M. on the 1st, and 2.29 A.M. on the 31st. His path is a short easterly one through Sagittarius, and the meridian altitude in London is less than 20 degrees.

Saturn is also in Sagittarius, a little to the east of Jupiter. On the 1st the planet rises about 4.25 A.M., and on the 31st about 2.35 A.M.

Uranus is in the most southerly part of Ophiuchus, nearly 4 degrees to the north-west of ξ, and, like Jupiter and Saturn, can only be observed in the mornings. On the 1st he rises about 2.30 A.M., and on the 31st about 12.31 A.M. The planet [illegible] quadrature on the 8th, and stationary on the 22nd.

Neptune may still be [illegible] after midnight. He is stationary on the 8th, a[illegible] quadrature on the 17th. On the 1st he crosses the meridian at [illegible] P.M., and on the 31st at 5.12 P.M. He remains [illegible] midway between χ^1 Orionis and 132 Tauri.

The Stars.—About 9 P.M., at the middle of the month, Aries will be 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 in the east; Hercules and Lyra low down in the north-east.

Minima of Algol occur at convenient times on the 10th at 9.52 P.M., on the 13th at 6.40 P.M., and on the 30th at 11.35 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.

No. 1.

(W. H. Gundry.)

1. Kt to Kt5, and mates next move.

No. 2.

(B. G. Laws.)

Key move—1. B to K3.

If 1. . . . P to K4,	2. Kt to Q6ch., etc.
1. . . . K to Q4 or R × P.	2. Q to Kt7ch.
1. . . . P × Kt,	2. Q × Pch., etc.

[There is, unfortunately, a second solution by 1. . . . B to Q6, threatening 2. Q to Kt7ch.]

Correct Solutions of both problems received from W. de P. Crousaz, J. Baddeley, Alpha, B. Harley, G. A. Forde (Capt.), F. J. Lea, G. Groom, C. F. P., C. C. Massey, W. H. S. M., J. T. Blakemore, (6), W. Nash, C. C. Pennington, N. L. Gillespie, S. G. Luckcock (6), E. Hunt, A. J. Head, Endirby, Vivien H. Macmeikan, J. Sowden, N. Buchanan, W. Jay (6), G. W. Middleton, Eugene Henry, H. S. Brandreth, N. K. Dutt, A. E. Whitehouse, F. A. Wilcock (6), W. B. Alldritt, A. W. Tyer, J. M. K., C. Child, H. Le Jeune, A. H. Machell Cox, J. E. Broadbent, G. W. (6), C. Johnston (6), H. Boyes, A. Jackson, A. C. Challenger (6), A. Dod (6), W. Smith, C. S. Hudson, S. W. Billings (6), F. Dennis.

All the above score 5, except where otherwise stated.

Of No. 1 only from H. W. Eleum. Of No. 2 from J. A. Nicholson.

For the first time probably in many years *no incorrect solution* to either problem has been received.

W. Jay.—See reply to "Endirby" below. A solution in less than the stipulated number of moves would count as an ordinary "cook." One other key, if there be one, should be sent with it.

F. A. Wilcock.—A very successful first appearance.

Endirby.—Nothing can be gained by sending more than two keys to any problem.

W. Nash.—Yes, your card gives 1. Q Q B3. I much regret your slip.

J. Baddeley.—Probably not; but if such a course should be deemed advisable, a suitable warning will be given.

E. Hunt.—Problems with more than one key may *possibly* be given intentionally in the later stages of the competition.

S. W. Billings.—It is not necessary to give more than two keys to any problem, or to say which is the author's intention.

C. S. Hudson.—You will see that your suspicions are correct. Considering the reputation of the composer it is strange that these suspicions were not shared by the large number of other solvers who gave B to Q6 only.

S. S.—Too late to reply to last month. You will see that your solutions were incorrect.

W. F. P.—Solution of No. 1 correct, but Croydon postmark was February 11th.

P. G. L. F.—Many thanks. They will appear next month.

R. J. Pearce.—Your communications have been handed to me. That which is remotely connected with Chess is noticed below. Please excuse my abstract of your paper.

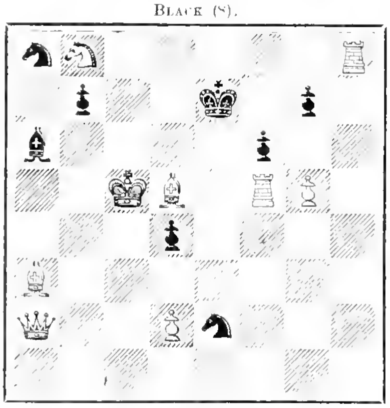
A table of the leading scores in the Solution Tourney will be given next month. Meanwhile some apology is due for the following attempts to atone for lack of difficulty by means of additional quantity.

PROBLEMS.

By C. D. Locock.

No. 1.

BLACK (8).

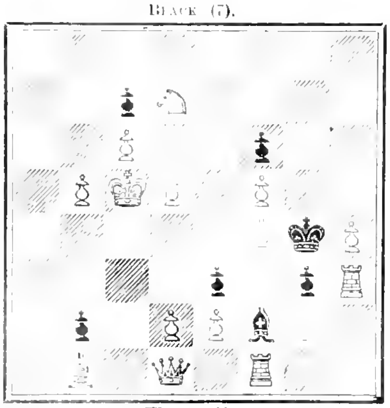


WHITE (9).

White mates in two moves.

No. 2.

BLACK (7).

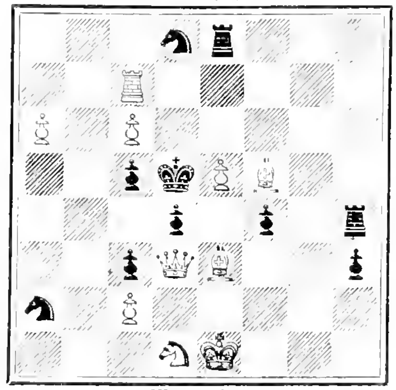


WHITE (15).

White mates in two moves.

No. 3.

BLACK (10).



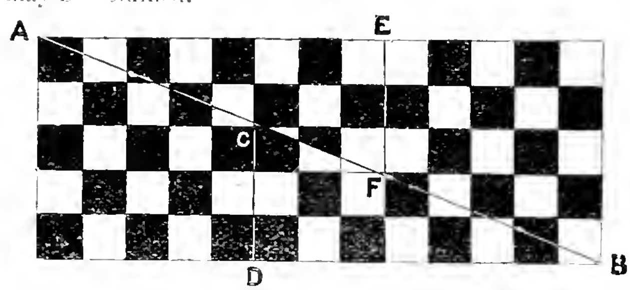
WHITE (10).

White mates in two moves.

CHESS INTELLIGENCE.

AN OLD CHESS-BOARD PUZZLE.

Probably most chess-players are acquainted with the device by means of which a chess diagram may be cut into four pieces and fitted together in such a manner as to form a rectangle of apparently 65 squares. The method is as follows: Cut off the 24 top squares of a diagram, and cut that piece into two halves diagonally, from corner to corner. Then cut the larger piece of 40 squares along a line drawn from the left hand bottom corner of Qsq. to the right-hand top corner of K5. By fitting these pieces together, a rectangle, apparently 13 × 5, may be obtained.



Mr. R. J. Pearce, of Auckland, New Zealand, sends a mathematical exposure of the fallacy. I have not space for his proof, and am doubtful whether it would be intelligible to all the readers of this column; but the gist of the matter lies in the fact that while the "fitting" along the lines CD and EF is quite correct, the "fitting" along AB is by no means so accurate. In fact AB, so far from being a straight line, is in reality an attenuated rhomboid, ACBF, having an area exactly equal to that of one square of the chessboard. That is, the complete figure is composed of diagram paper amounting in all to 64 squares intersected by a small rivulet of ink or other paper equal in area to one square; the result being a true rectangle of an area equal to 65 squares. The difficult part of Mr. Pearce's proof lies of course in calculating the area of the parallelogram ACBF.

KNOWLEDGE

AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

VOL. XXIV.] LONDON: APRIL 1, 1901. [No. 186.

CONTENTS.

THE NEW STAR IN PERSEUS.

By A. FOWLER, F.R.A.S.

ON the early morning of February 22nd Dr. Anderson, of Edinburgh, observed a star of magnitude 2·7 in the Milky Way in the constellation Perseus, in a region where no star had been previously known to exist. Another "new star"—to be henceforth known as Nova Persei, in accordance with the usual custom—had therefore, appeared in the heavens, and, thanks to Dr. Anderson's speedy transmission of the news to the Royal Observatory at Edinburgh, the whole astronomical world was soon actively interested in the new arrival.

At the time of discovery the star already surpassed in brightness all the novæ that had been observed since 1866, and the fact that on the evening of the 22nd it had reached the first magnitude encouraged the hope that it might even rival the famous new stars of 1572 and 1604, which are inseparably associated with the names of Tycho Brahe and Kepler. The hope, however, was not realised, for in the course of a few days it was seen that the star was distinctly on the down grade. Still Nova Persei ranks as the brightest star of its class which

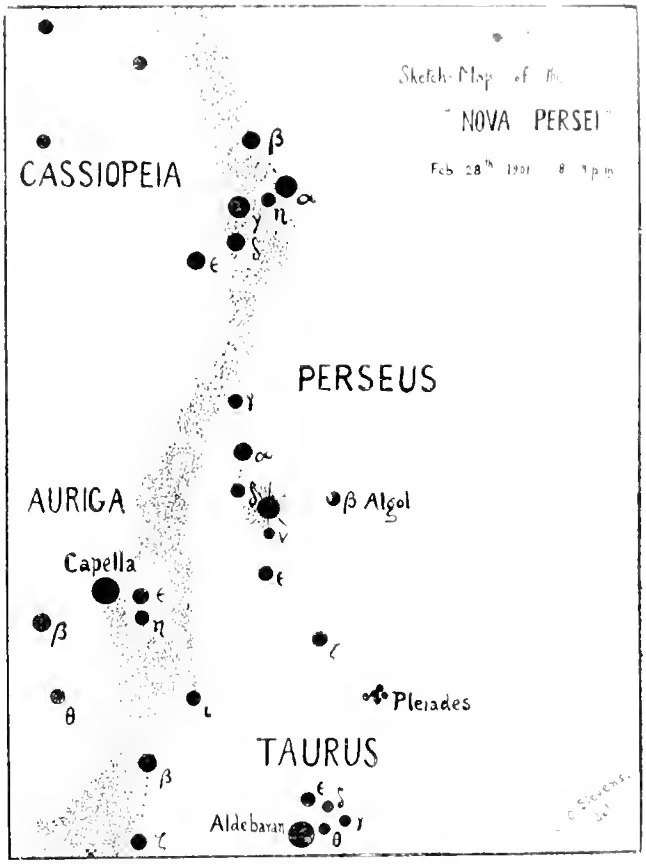


FIG. 1. Chart showing position of Nova Persei.

has appeared for nearly three centuries, and is almost the only one during this period which has been certainly observed before attaining its greatest brilliancy.

One of the first questions which naturally arises is how long was the star bright before its discovery? The wonderful photographic "star traps" organised by Prof. Pickering at Harvard and Arequipa, by which all the principal stars visible every fine night are duly registered, give a very definite answer to this question. The Harvard plates taken on the 19th of February gave no indications of any star as bright as the 11th magnitude in the place now occupied by Nova Persei, so that at that time there was certainly no star of a ten-thousandth part of the luminosity of that which was seen three days later. It is, of course, impossible to say what the actual brightness was before this amazingly sudden and tremendous outburst of energy took place, and equally impossible to believe that there was no body at all in that part of space prior to the conflagration.

During the early stages of visibility of the new star the weather in this country was by no means favourable, and many who wished to carry on investigations had to be contented with occasional glimpses. A few such glimpses at Kensington on the night of the 22nd showed that the star was of at least first magnitude, but no photographs could be taken there before the 25th. At Edinburgh, however, Dr. Copeland and his assistants were a little more fortunate, and noted that on the 22nd, at 6.58, G.M.T., the star was about 0.3 mag. brighter than α Tauri, and at 8.10 p.m. equal to Procyon, while on the 23rd, at 8.10 p.m., the nova exceeded Capella by 0.2 mag. On the 25th, observations at 6.30 p.m. at Kensington showed the nova to be intermediate between Aldebaran and Capella, but by midnight the star had perceptibly dimmed. By the 28th of February, the star had dwindled to about 2nd magnitude. Observations made by Colonel Markwick and others also indicate that the greatest brightness, near magnitude 0.3, was reached about the 23rd of February.

Continued observations of the brightness of the star will be of great interest, and to those making estimates the following list of the magnitudes (Oxford Photometry) of the stars shown in Fig. 2 may be useful:—

Name.	Mag.	Name.	Mag.	Name.	Mag.
Capella	−0·08	τ Persei ...	4·07	λ Persei ...	4·39
α Persei ...	1·93	κ "	4·08	o " ...	4·40
β "	2·40	η "	4·13	ψ " ...	4·48
γ "	3·06	μ "	4·17	16 "	4·77
ζ "	3·09	ρ "	4·24	π "	4·89
δ " ...	3·11	θ "	4·26	ω "	4·94
ϵ " ...	3·13	48 "	4·30	30 "	5·55
ν "	4·06	ι " ...	4·39	13 " ...	5·66

The latest observation to which reference can be made in the present article was made on March 12, when the magnitude of the nova was estimated to be about 4.0.

The colour of the new star has also been changing. At the time of discovery, Dr. Anderson considered it to be bluish white, but a gradually increasing redness appears to have set in about the 25th of February, and by March 2nd the star was distinctly of a red tinge to the naked eye.

It is undoubtedly to the spectroscopic observations that we must look for the greatest additions to our knowledge of these strange outbursts, and it is satisfactory to know that excellent records of the spectrum have been secured. The earliest of these observations was made on February 22nd by Dr. Copeland, who found that the spectrum was then a continuous one crossed by a few dark lines, and described it as of a feebly developed solar type. At Harvard the spectrum was photographed on the 22nd, a few hours after Dr. Copeland's observations, and it was stated that the negatives showed 25 dark lines, six of them with bright lines on their less refrangible sides, and one with a bright line on the violet side.

In a communication to the Royal Society on February the twenty-eighth, Sir Norman Lockyer stated that 10 photographs had been obtained at Kensington on February 25th, and it was remarked that the spectrum of the latest nova was strikingly similar to that of Nova Aurigæ (1892). Brilliant lines of hydrogen at C and F, three strong bright lines in the green, and one in the yellow, each accompanied by a dark line on the violet side were obvious in a glance at the spectrum. The photographs showed similar pairs of dark and bright lines in other members of the hydrogen series, as well as in the K line of calcium, in addition to numerous other dark and bright bands. All the lines were very wide, and the separation of the bright and dark adjacent lines indicated a relative velocity of the two light sources of at least 700 miles per second, assuming that the displacement of the dark lines was due to motion in the line of sight. Some of the bright lines were apparently reversed—that is, there was a dark line down their centres. The velocities of the two light sources indicated by the spectrum were determined by photographing the spectrum of γ Orionis side by side with that of the nova; this disclosed the fact that the bright line source, apart from internal movements, was almost at rest with regard to the earth, while that giving dark lines was approaching the earth with the tremendous velocity already stated.

The spectrum is by no means easy to unravel, owing to the great breadth of the lines, both bright and dark. Spaces between bright lines may easily be mistaken for dark bands, and *vice versâ*. Nevertheless, starting with the supposition that as some of the lines are not unfamiliar, most of them may be met with in other stars, it seems possible that the true dark lines may be discriminated by a process of matching with stellar spectra. In this way Sir Norman Lockyer has concluded that the dark line spectrum of February 25th was very similar to that which the spectrum of α Cygni would assume if all its lines were to become greatly distended through violent internal motions or other causes. If this be a correct interpretation, the spectrum then consisted largely of the enhanced lines* of various metals, and a temperature considerably greater than that of the sun or Sirius was indicated at this stage in the history of the new star. The relation between the spectrum of Nova Aurigæ and that of the solar chromosphere to which attention was drawn by Vogel and others thus appears to have depended upon the presence of enhanced lines in each.

In another communication to the Royal Society on March the seventh, Sir Norman Lockyer gave an account of photographs taken on February 28, and March 1, 3, and 5, from which it appears that considerable changes in the spectrum were taking place. The continuous spectrum and bright lines other than those of hydrogen were rapidly fading; the bright hydrogen lines became very complex and were possibly quadruple; and some of the dark lines were dying out while new ones appeared. Careful examination of the photographs left little doubt that the principal bright lines in the green, near wave lengths 4924, 5018, and 5169, and a less bright one at 5317, were due to iron vapour at a very high temperature, while many others in the more refrangible parts of the spectrum also corresponded with high temperature metallic lines. Helium lines appeared to be absent, and the line in the yellow was probably D and not D^3.

During this period a great part of the light of the star was due to glowing hydrogen, and the star was, therefore, red for the same reason that many of the solar prominences are red.

Excellent photographs of the spectrum have also been obtained by Father Sidgreaves, Mr. Newall, and Dr. McClean; these exhibit the features described above, and Dr. McClean finds many coincidences between lines of the nova and those of Sirius, as would be expected, since the latter include numerous enhanced lines. M. Deslandres has also given a good account of the photographic spectrum (*Comptes Rendus*, March 4).

A further description of the photograph taken at Harvard on the 22nd of February, and details of others obtained on the 23rd, 24th, and 25th, have been received

* Enhanced lines are those which are brightened in the spark spectrum as compared with the arc spectrum, and since these lines occur without the arc lines in the spectra of some stars, which there is reason to believe to be at a very high temperature, they are regarded by Sir Norman Lockyer as indicative of high temperature when they are met with in other spectra.

from Prof. Pickering (*Harvard* [illegible] No. [illegible]). It [illegible] extremely fortunate that the spectrum was photographed both before and at maximum brilliancy. At these stages in the history of the star, Prof. Pickering finds the spectrum to have been distinctly of the Orion type, with a few bright lines, chiefly on the red sides of dark ones. By the 24th, however, the spectrum had undergone a most extraordinary change, and then resembled the well-known spectrum of Nova Aurigae, as it did on the 25th when photographed at Kensington. The full significance of this transformation is not yet clear, but it was evidently a most important event in the development of the new star.

The final stage, if Nova Persei behaves like Nova Cygni, Nova Aurigae, and others, which it resembled soon after discovery, will be that of a planetary nebula.

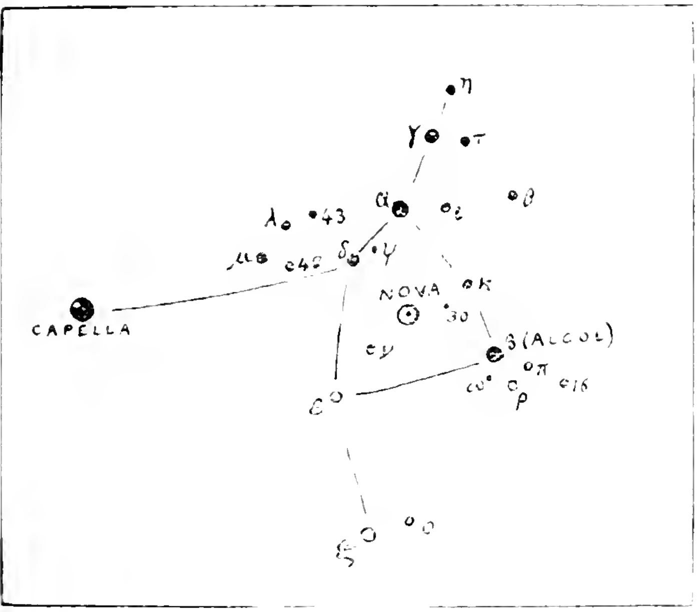


Fig. 2.—Perseus.

It may be worth while to add that up to March 3rd the principal features of the beautiful spectrum of Nova Persei were observable with a McClean spectroscope in use with a two or three inch telescope. This form of spectroscope is almost as easy to manipulate as an ordinary eyepiece, and is especially useful when it is not intended to take measurements of the lines.

Numerous theories have been advanced to account for such outbursts as that of Nova Persei, but judgment on them should perhaps be suspended until the present nova has been more completely studied. Still, a few remarks on this question may not be out of place. Attempts to explain a new star as the result of some action taking place in a single body have not been considered successful, chiefly on account of the difficulty of explaining the nebular state which most of them finally assume, and the collision theory in one form or another appears to be of much more general application. On Sir Norman Lockyer's hypothesis, the fact that a nebula remains is taken as an indication that a nebula —previously unrecorded—was there to begin with, and the outburst is attributed to the passage of a dense swarm of meteorites with great velocity through the sparser swarm composing the nebula; the denser swarm, on this view, is responsible for the dark line spectrum and the sparser one for the bright lines. Mr. Monck, in 1880, compared the [illegible] which takes place in a shooting star, and [illegible] new stars are dark or faintly luminous [illegible] short-lived brilliancy by rushing th[illegible] gaseous masses which exist in space. [illegible] view has been adopted and extended by P[illegible] S[illegible]. Many of the phenomena seem to be explained [illegible] these suppositions, but collisions of small bodies appear to be most consistent with the rapid cooling which takes place. In either case, the original nebula (or meteoric cloud) might be expected to shine more brightly after the collision than before, in consequence of the disturbance to which it has been subjected. The fact that gaseous nebulae, like the new stars, occur in greatest abundance in the neighbourhood of the Milky Way strengthens the collision theory, and it may be noted, too, that on account of their greater dimensions nebulae are much more likely than stars to be struck by wandering bodies.

It may be remarked that there is another possible explanation of the pairs of bright and dark lines which are found in the spectra of new stars, besides that which refers them to two bodies having a great relative velocity in the line of sight. The lines in certain spectra are displaced slightly when the vapours producing them are under pressure, and Prof. Wilsing has found that in spark discharges through liquids, pairs of lines somewhat resembling those of new stars appear in the spectrum. The evidence on this point, however, is incomplete.

As the great brightness of Nova Persei allowed of the application of powerful spectroscopes, it may be expected that a complete study of the spectra which have been observed and photographed will throw additional light on the origin of such celestial outbursts, and doubtless also on various other questions relating to the progress of events in stellar evolution.

It is satisfactory to know that the new star was seen independently by several observers, though Dr. Anderson appears to have been the first in point of time, and it was through him that the news was at once circulated. This, it will be remembered, is the second discovery of the kind with which Dr. Anderson's diligence has been rewarded, the previous one being that of Nova Aurigae in 1892.

THE WHITE NILE—FROM KHARTOUM TO KAWA.

AN ORNITHOLOGIST'S EXPERIENCES IN THE SOUDAN.

By Harry F. Witherby, F.Z.S., M.B.O.U.

I.—THE DESERT RAILWAY, KHARTOUM AND OMDURMAN.

Shortly after the battle of Om Debreikat and the death of the Khalifa Abdullahi, I found that it would be possible to travel in the Soudan. For fifteen years the country had been in the hands of powerful savage tribes, and before that time English naturalists, and especially ornithologists, had greatly neglected the Soudan, although some Germans, as for instance Brehm, Heuglin and von Muller, had done excellent work there. The country being thus more or less new ground to English ornithologists, I was the more anxious to visit it, and study the birds of a small portion at all events of what had become English territory, at least by right of conquest.

So on the last day of February, 1900, I set out from England, joining at Marseilles Messrs. E. H. Saunders and C. F. Camburn, two taxidermists who were to accompany me, and we reached Cairo on March 6th.

The journey from Cairo to Wady Halfa, even under the new conditions created by the railway, is to-day so well known that it requires but a brief description.

Instead of a long journey by boat up the Nile one can now travel from Cairo to Assouan in about 22 hours in a train, which for ease and luxury would not shame any European railway. Notwithstanding the lowness of the Nile at the time of our visit, the country from Cairo to Luxor was green and luxuriant. Camels, cattle, sheep and goats abounded, and everywhere the half-naked people of many shades of chocolate, brown, and black were working on the land. Beyond Luxor the area of cultivated land grew gradually less. Wells, sakiehs, and shadoofs were not so frequent, villages were passed at longer intervals, and the inhabitants and their cattle became more rare in the landscape.

At Assouan we found every comfort. From this point to Omdurman we travelled under the joint Government of the Queen and Khedive. From Assouan a short piece of line took us to Shellal, above the first cataract, and there just opposite the Temple of Philæ we embarked upon a steamer, for no railway yet connects Assouan and Wady Halfa. And here the character of the country completely altered. The day before we had travelled through a flat fertile land, whilst now we were steaming up the great river through a wild and desolate country of bare rocky hills, and having the merest strip of cultivated land by the edge of the river.

Here and there, however, where flat ground was available between the river bank and the foot of the hills, as for instance at Korosko, cultivation was carried on. But this was only possible with the aid of an elaborate, although primitive, system of irrigation. The sakieh, an endless chain of pitchers, somewhat in the form of a water-wheel, turned by oxen, and the shadoof, a bucket at the end of a long lever balanced by a lump of mud and worked by men, were employed in raising the water from the river above the high bank. Often two sakiehs, or four or five shadoofs one above another, or a combination of sakiehs and shadoofs, were necessary to lift the water, so low was the river and so high was the bank.

Of birds there were few in this reach of the river, but we noticed particularly that the hooded or grey crows* so common north of Assouan, were no longer to be seen, their place being taken by a crow of pure black and white,† which was to be found as far south as we afterwards travelled.

The scenery was bold and impressive, and the colouring exceedingly beautiful. The blue-grey river, edged with a strip of bright green crops, and here and there a patch of dazzling white sand, led one's eye away above the bank where the desert seemed to have overflowed, and poured forth between the rocks great streams of sand of a deep rich orange colour. A background of pinkish hills, and the pure blue sky above, completed a scheme of colouring difficult to surpass. One night by the light of a brilliant moon all these colours were to be clearly distinguished, even to the pink of the distant rocks and the blue of the sky, but of such delicacy was the colouring that the whole scene became etherealised.

Our progress by the river was slow and laboured. Owing to the shallowness of the water, it being the midst of one of the driest of dry seasons, the steamer grounded and stuck continually, notwithstanding its flat bottom and shallow draught. By dint of much twisting and turning and a vast amount of hard labour on the part of our crew in poling and hauling, as well as in lightening the boat, we were not called upon to wait until the Nile rose before reaching our destination. Judging by their constant and hearty calls for aid from above, one could well believe that the crew ascribed this good fortune to the will of Allah and his Prophet rather than to their own exertions.

So we passed rocky Korosko, Ibrim perched on the top of a high and precipitous cliff, the wonderful rock temple Abu Simbel, and in four days from Assouan arrived at Wady Halfa.

Once a miserable village, Halfa now boasts of great workshops fitted with all the necessary machinery and appliances to keep in repair, and even to manufacture,

A Sakieh.

everything connected with a railway, and the new town has been appropriately termed a miniature Crewe. From Halfa the wonderful railway which bridges 230 miles of waterless desert originated, and from Halfa to an ever increasing distance each day, with marvellous regularity during its construction, ran two trains with construction materials, and water and food for the great army of workers at railhead. In eleven months from its commencement all difficulties, and there were many, were overcome, and a railway which the best authorities had dubbed as the idea of a lunatic was completed. The journey from Halfa to Abu Hamed formerly occupied some ten days. It is now possible by this "short cut" across the desert to accomplish it in about as many hours. Of course this railway, both as regards permanent way and rolling stock, has vastly improved since the days of the expedition which culminated in the battle of Kerreri and the capture of Omdurman, and it has been extended from the Atbara, its former southern terminus, to the banks of the Blue Nile opposite Khartoum.

We travelled up in the last so-called tourist train of the season. This train was put together at Halfa, and many of its fittings were made there. It was somewhat devoid of cushions and elaborate fittings, which

* *Corvus cornix*, Linn. † *Corvus scapulatus*, Daud.

was only a gift in so dusty a country. But as far as comfort went one could wish for nothing better. Every necessity was on the train, cars for sleeping in, cars for dining in, cars for smoking in, an excellent *cuisine*, and even bath rooms. We stopped for every meal on account of the jolting of the train. At first the dust was rather a trial, but the quantity of it depends much upon the position in the train which one occupies, and also upon the direction of the wind. And after all one soon gets accustomed to eating, drinking, and wearing dust. On our journey up we accomplished the distance of 576 miles from Halfa to Halfaya on the Blue Nile, including all stoppages, in 31 hours. But on the journey down in an ordinary train, which did not stop for meals, we did the distance in 23 hours. During part of this time we ran at the rate of 40 miles an hour with an excellent American engine, one of two engines which had to be obtained from America, because at the time they were urgently required, British engineers were fully employed in a strike and could not attend to such business as building railway engines. From Halfa to Abu Hamed the railway runs across a bare desert far from the river, which here takes a great sweep. Sand, flat and monotonous, as far as the eye can reach, stretches out on every side. Here and there a stunted mimosa bush or a black rock rising conspicuously from the sand serves but to accentuate the loneliness and barrenness of the scene, while the mirage on every side tantalizes the eye with its shining dazzling mockery. At intervals along the single narrow track are "stations," so called, but otherwise they are nameless being only numbered one to nine. Each of these boasts of one or two tents, and some tanks of water. At some are stores of coal, and at two there are pumps, which bring up from deep below the sand that priceless water which, with "Kitchener's luck," was happed upon during the construction of the railway, when water was so valuable for men and engines that a whole month was gained by these finds. At several of these stations we saw ravens,‡ and at one, kites.§ What induces these birds to live in such forsaken spots, and upon what they feed, unless

The River Bank, Omdurman.

it is on just the scraps they can pick up round the tents, and how they get water to drink are puzzles difficult to solve.

At Abu Hamed, with its small white-washed station house, the river was reached again, and here a few scraggy dom palms, the hard round fruit of which has nicknamed Dervish bread, are a delight to the weary eye. From this point onwards the country [illegible] Mimosa scrub and stunted acacia struggle for an existence in the gritty sand, dark rocky hills rise in the distance, and a group of gazelles or a flock of small birds may now and again be seen.

We passed many a place made famous by conflict, Berber, the Atbara with its fine bridge, Shendy opposite Metemma, and at length arrived at the railway's unpretending southern terminus, Halfaya, a collection of a few huts upon the sand on the north side of the Blue Nile almost opposite Khartoum. Here we were greeted by a dust storm, which is no unusual thing at Halfaya, a fact which has given the place a nickname of much the same sound but of a deeper significance. After considerable delay we embarked on a steamer—a dahabeah—which was to take us over to Omdurman, and upon which we were to live during our brief sojourn there.

The "Bazaar" at Khartoum.

Steaming down the Blue Nile towards Omdurman we had a good view of Khartoum, which is built along the southern bank of the river amidst a grove of palm trees. It will be remembered that Khartoum was deserted, and converted into little less than a heap of ruins by the Mahdi, who set up his capital at Omdurman, a mere village at the time of the fall of Khartoum.

We are now reverting to the old order of things, and although at present nearly all the business both official and private is transacted at Omdurman, yet Khartoum will soon become again the chief town and centre of the Soudan. At the time of our visit few buildings in Khartoum were completed, but along the bank of the river houses and government offices were springing up, to say nothing of a fair-sized hotel. But the buildings to which most interest attaches are the Sirdar's palace and the Gordon Memorial College. The palace, which had been completed and occupied for some time, is a large and imposing though somewhat bald and ugly structure. It is built on the spot formerly occupied by Gordon's palace, and portions of the old foundations and walls have been utilized. At a little distance from the Palace a mass of scaffolding and stone showed where the Gordon Memorial College was growing into existence.

As we neared Omdurman the shadow of a cloud seemed to be hanging over part of the river, the edge of the shadow being clearly defined in an uneven line even at some distance. But a glance upwards showed no cloud. The ragged line which seemed to mark where the shadow

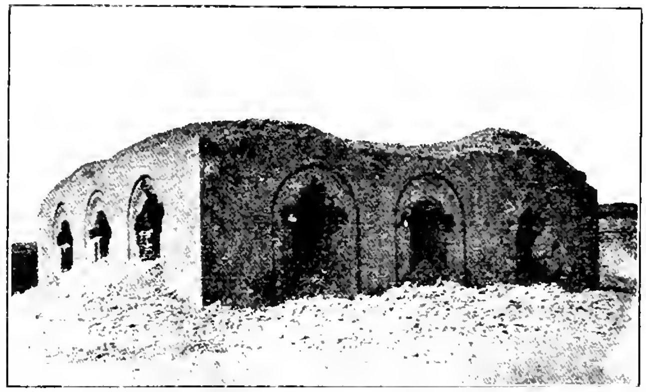
‡ *Corvus umbrinus*, Sundev.

§ *Milvus aegyptius*, Gm.

ended and the sunlight began was in reality the point at which the Blue Nile, with its clear dark blue waters, joined with the White Nile, the waters of which are heavily charged with sand and have a whitish appearance. As we passed over the line of junction, the idea of the shadow still prevailed, and so definitely was the thick grey water separated from the clear dark water that no mixing appeared to be taking place. We steamed across the united rivers, which form the Nile of Egypt, and tied up to the bank at Omdurman alongside three of the gunboats which had played so important a part in the "river war." Near by stood the works where many an old steamer, which most engineers would have broken up for scrap iron—one at all events dating from Gordon's days—has been miraculously patched up and made to work again.

There was much to be done at Omdurman, and the dust and heat as well as the extent of the place by no means facilitated matters. The town is a most bewildering place. It is built on a fairly flat piece of bare desert about six miles long by an average of two miles wide. This piece of desert is a mass of low mud houses surrounded by compounds and separated by high walls. A few broad straight roads, which are mere sand, and innumerable narrow winding alleys, intersect the collection of huts and compounds, while here and there is a yawning pit, or an acre or so of broken-down houses, such as those in the Baggara quarter, which is now but a heap of mud. Although the place itself has a peculiar fascination, perhaps on account of its history and the many unlooked-for secrets these numerous walls may even now be hiding, there is not much of interest to see in Omdurman. The houses are mostly built on the same plan—four mud walls with a flat roof made of rafters covered with straw or matting, a verandah in front, and sand for the floor. The few which have two stories were formerly occupied by the Khalifa and his chiefs. The Khalifa's own house stands at the corner of an immense square some 600 yards long. Outside the house in the square one can see the remains of what was once a brick platform, from which the Khalifa used to preach to his thousands of fanatical followers packed in the great square. There on the last day of August, 1898, he held his last review, inciting the assembled hosts in a vigorous harangue to fall upon the invading army of British and Egyptians, to drive them into the river and annihilate them, and there the dense mass of misguided savages clad in their patched jibbehs shook their spears and became mad for the blood of the accursed infidels.

In 1900 in the same square a few orderly squads of Soudanese, dressed in neat khaki uniforms, might be seen industriously drilling to words of command given by a sergeant as black as themselves, with neither an Englishman nor an Egyptian present. Yet most of these Soudanese were the same men who had thirsted for and spilt our blood such a short time before. That they were no less eager to fight one could tell by the fierce energy of their drill, but above them, near their former master's house, floated two flags side by side—the Union Jack and the Crescent and Star, and around them, working in the houses so lately occupied by their ignorant and brutal chiefs, were a few British officers in their shirt sleeves administering the Soudan. Just outside the great square is a small enclosure surrounded by high walls, and in this may be seen a great heap of bricks with a square of arches round it—all that is left of the Mahdi's tomb, for ten years the most sacred and revered object in the Soudan. Leading out of this enclosure is a compound with a small mud house, the English Officers' Club, and here every evening the Soudanese may catch a glimpse of the members playing tennis or racquets. One of the most interesting places in Omdurman, although now in



The Ruins of the Mahdi's Tomb.

ruins and difficult to find, is the "Saier," the awful prison in which Charles Neufeld and so many other victims of the Khalifa spent years in torture. Slatin Pasha writes thus of the horrors of this place:—"A gate, strongly guarded day and night by armed blacks, gives access to an inner court, in which several mud and stone huts have been erected. During the day-time, the unhappy prisoners, most of them heavily chained and manacled, lie about in the shade of the buildings. . . . . At night the wretched creatures are driven like sheep into the stone huts, which are not provided with windows. . . . . It is a painful sight to see scores of half-suffocated individuals pouring out of these dens, bathed in perspiration, and utterly exhausted by the turmoil of the long and sleepless night."

The walls round this awful place are now broken and crumbling, and only portions of the huts remain. But enough can be seen to make it almost impossible of belief that any of the crowd who were forced into these dens could have lived through one night. That many succumbed we know. Outside the huts in the small compound could be seen the remains of three or four brick platforms on which the most favoured prisoners were allowed to rest at night.

To turn to pleasanter things. Of the birds of Omdurman itself there is little to say. There is not a tree near the town, nor is there any vegetation. Consequently there is little else but carrion on which a bird could feed. Kites and Egyptian vultures,|| both excellent scavengers, are the most conspicuous birds. And all over the town are homely house sparrows,¶ a little smaller and more brightly coloured than our familiar birds, but every whit as cheeky and pushful. Down by the river one may often see a striking black and white kingfisher,** hovering over the shallow water, and every now and again dropping down to the surface like a stone. If you watch carefully you will notice that this graceful action is repeated many times before the bird makes a successful plunge and rises with a fish.

Across the river, on a sandbank, a few pelicans,†† some

|| *Neophron percnopterus*, Linn. ¶ *Passer rufidorsalis*, Brehm.
** *Ceryle rudis*, Linn. †† *Pelicanus onocrotalus*, Linn.

graceful egrets and herons‡‡ and other wading birds may be distinguished.

When once we got into the swing of things and began to learn our way through some of the mazes of the town, preparations for our journey up the White Nile did not take long. Time being precious I determined to spend as little as possible in travelling, but to work thoroughly a small tract of country from Omdurman south along the White Nile. With this in view we decided to travel entirely by land, as being a more thorough method of exploring the country, although much slower and more fatiguing than travelling by boat. Our task in Omdurman was to obtain permits and servants, and animals to carry our baggage and ourselves. At first we tried to buy camels, and several Arab sheikhs were induced to make a parade of their beasts before us. Feeling sure, however, that such camels as were shown us would become the prey of dogs and vultures after a day's march, we waived their owners politely away. At this deadlock I learnt most opportunely that His Excellency the Sirdar, Sir Reginald Wingate, through the agency of Bimbashi F. G. Newall, of the Intelligence Department at Omdurman, had most kindly already hired baggage camels for me from the sheikh who contracts to supply the Government. This difficulty being thus pleasantly overcome we turned our attention to procuring our own mounts. Good horses and saddles were difficult to obtain, and to feed horses in such a dry season would have been a difficult matter. Riding-camels were expensive, and a doubtful luxury. We, therefore, fell back upon donkeys. But the donkey of the Soudan is a miserable little beast compared to that of Egypt, and although our animals, bought after a wearisome amount of bargaining and trials, carried us fairly successfully, we often wished for better mounts. We made a great mistake in using the wide wooden native saddles, which even with the aid of pads and a sheepskin became exceedingly uncomfortable at the end of a long day's march. Quite the mount for our journey would have been a bicycle. The desert tracks, at all events as far south as we travelled, are quite hard and smooth enough to make bicycling possible and often enjoyable.

A permit to travel as far south as we cared to go on the east bank of the White Nile was granted us, but we were prohibited on account of the unsettled state of the country from journeying on the west bank at all. This somewhat altered my plans as I had hoped to be able to make several excursions into Kordofan from the west bank.

Licenses to carry arms and to shoot were also necessary. By licensing each gun, rifle, or revolver, instead of the user, the authorities make a distinct gain for the Revenue. Some very fair game laws have also been drawn up for the Soudan. No one is allowed to kill the zebra or the ostrich. A special license authorises the holder to kill a very limited number of adult male buffalo, elephant, giraffe, hippopotamus, and rhinoceros, and for each animal killed a special fee has to be paid. A less expensive license allows one to kill antelope, gazelle, and warthog. All other animals and birds may be shot by the holder of an ordinary gun license. These regulations might well be revised and made still more useful, and no doubt Capt. Stanley S. Flower, who has lately been appointed Director of the Soudan Wild Animal Department, will see to it that better protection is afforded to many scarce animals, such as giraffes and some of the rarer antelopes.

‡‡ *Herodias ralloides*, Scop.; *Herodias garzetta*, Linn.; *Ardea purpurea*, Linn.

FLOWERING PLANTS.

WITH ILLUSTRATIONS FROM BRITISH WILD-FLOWERS.

By R. Lloyd P[illegible]

II.—CONCERNING LEAVES.

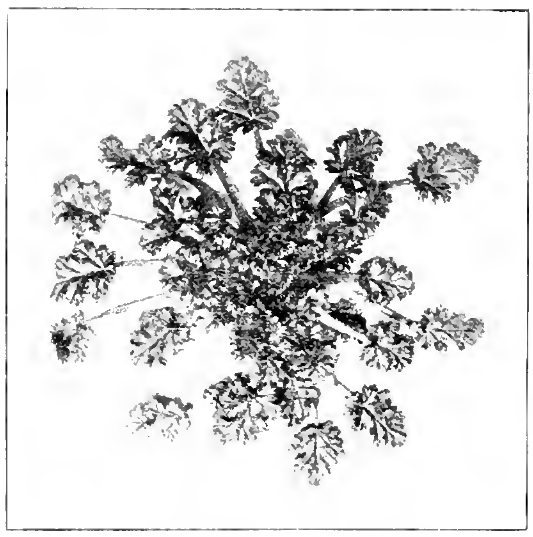
The stems of plants, as stated in my [illegible] are the framework on which the leaves [illegible] are spread out to catch the light and air, and [illegible] definite relations existing between the form, position and strength of stems, and the shape, weight and function of the organs which the stems support. The branches of an Apple or Pear tree have to be sufficiently strong not only to withstand the stress of winter gales, and the burden of the wealth of blossom and foliage of early summer, but also the weight of the abundant fruit of autumn. It is interesting to note that among our cultivated fruits, strength of stem has not kept pace with the increase in weight of fruit due to artificial selection, so that in gardens our artificial fruits must needs, in a season of abundance, be supported by artificial stems—by props and crutches, lest, like the legs of the prize turkey in the "Christmas Carol," the branches might snap like sticks of sealing-wax. In evergreen trees, the weight of snow is a serious contingency that must not be neglected. Nor must the chance of accident owing to wandering animals be left out of account. The young Ash saplings, a few feet in height, are as pliable as willow-wands, and spring back into their places as we force our way through them; but the knobby twigs of an old Ash tree, which swing clear in the air high overhead, are brittle, and snap across if we attempt to bend them; the elasticity of the whole bough is sufficient to bring them safely through the heaviest storm.

Between the form of a twig and that of the leaves which it bears we can generally at once perceive a relation. The little leaves of the Birch are borne on twigs slender as a piece of twine. The Oak and Elm, with larger leaves, require a stouter twig for their support. The Sycamore and Ash have twigs which are stouter still. The large leaves of the Horse Chestnut are borne on very thick twigs, in which the principle of the hollow column is introduced.

The arrangement of the leaves on the stem, or *phyllotaxis*, is a question of the first importance. The leaves must be so grouped that all may receive as much light as possible. So far as can be arranged, there should be no overlapping, nor should any of the available space be wasted. On the stem of the Ash, or Sycamore, or Teazel, the large leaves are arranged in alternate pairs, the direction of the axis of each pair being at right angles to that of the next. Thus two spaces or *internodes* separate any pair of leaves from the nearest pair which, being placed in the same position, might overshadow it. This is a very simple case, which we shall find to be the rule when we examine plants in which the leaves are borne in opposite pairs. When leaves are borne in whorls of three a similar rule will be found to hold good. The position of the leaves of any whorl is such that they are vertically below or above the *spaces* between the leaves of the next whorl. It will be seen at once that the amount of light received by each leaf is materially increased by this arrangement. If in a theatre we can look between the heads of two people in the row immediately in front of us, the head of a person in the next row beyond, even though directly before us, does not much interfere with our view of the stage. In most cases, however, the arrangement of the leaves on the stem is much more complicated than this. The leaves usually emerge singly. If we join by a line the point of emergence of a leaf with that of the next leaf above it on a stem, and that again with the next, a spiral will be the result, along which at equal intervals we reach the *nodes*, or points where leaves are borne. And the distance between these nodes will be always found to bear some definite relation to the total length of the spiral line in making one complete revolution round the stem. If the distance from node to node is one-half of this whole distance, it signifies that the leaves are borne alternately on opposite sides of the stem, each leaf being vertically below the second one higher up the stem—a very common arrangement. Or the leaves may be borne three to each spiral revolution, so that the position of each leaf shifts one-third way round the stem as compared with the preceding leaf. If we look along such a stem, the leaves will appear to be borne in three vertical rows, with an equal angle between each. Examining some other plant, we may find that we have to go as far as the fifth leaf before we find one vertically above the one from which we started, and if we measure the horizontal distance from any leaf to the next above or below it, it will be found to equal two-fifths of the total circumference, so that we have to go five times two-fifths way round the stem, or two complete revolutions, before completing the cycle. This is called a two-fifths phyllotaxis. In many other cases, the arrangement is immensely more complicated, and need not be entered on here. What is important for us to note at present is that by means of this orderly mathematical arrangement, the leaves are so distributed that each fulfils its functions to the best advantage.

The shape of leaves offers an almost inexhaustible field for observation and scientific speculation. Mr. Ruskin has said:—"The leaves of the herbage at our feet take all kinds of strange shapes, as if to invite us to examine them. Star-shaped, heart-shaped, spear-shaped, arrow-shaped, fretted, fringed, cleft, furrowed, serrated, sinuated, in whorls, in tufts, in spires, in wreaths, endlessly expressive, deceptive, fantastic, never the same from footstalk to blossom, they seem perpetually to tempt our watchfulness and take delight in outstripping our wonder." The size of leaves will naturally vary inversely as their number. A plant of a certain size—say a tree—will require a certain total area of leaf for the manufacture of the requisite amount of plant-food. If we cut the branch of a Horse Chestnut and of a Beech where each had exactly a diameter of one inch, or two, or six inches, and counted and measured the leaves on each, while the number of Beech leaves would immensely exceed the number of Chestnut leaves the total leaf-area would be about the same in each case. This area of green leaf, then, must be spread out to the best advantage. In this connection, a beautiful relation between the shape of leaves and their arrangement on the stem may frequently be remarked. Lay a twig of Beech on a sheet of white paper, and note how small are the interstices between the leaves through which the paper may be seen. The shape of the leaves, and the intervals at which they are borne, are so related that an almost continuous expanse of green is offered to the sunlight. A more remarkable case may be seen in the Lime, whose leaves are quite inequilateral, being contracted on one side at the base and expanded at the other, in order the more exactly to fill the space which is available. The Elm likewise furnishes a beautiful example of close-fitting leaves. In most trees in which, like the Beech, Hazel, and Elm, the leaves lie in close-ranked rows in the same plane as the twig which supports them, we find more or less oval leaves, their breadth varying with the space between the leaves, *i.e.*, the length of the internode. In trees such as the Horse Chestnut or Sycamore, on the other hand, the leaves grow in opposite pairs, and are typically arranged on upright twigs, the leaf-stems projecting at a wide angle from the twig, with the surface of the leaf horizontal. In this case space is not so curtailed; the leaf is larger, and more or less circular in outline; and the great increase of length in the internodes, as compared with the trees lately considered, prevents a too great overshadowing of the lower leaves by those higher up the shoot.

In plants which have a very short axis—which have in popular language "no stem"—a difficulty arises as to how all the leaves shall receive a due amount of light, since all arise from the same point. This is met in several ways. The leaves are often placed at different angles, the outer leaves, which are the lowest and oldest, spreading horizontally near the ground, the newest rising almost vertically in the centre, the intermediate being disposed at various angles between these extremes. Another solution of the difficulty is effected by a continued growth of the leaf-stalks, each leaf steadily pushing itself outward so that the whole form a slowly expanding circle, in which each leaf-blade successively occupies a position commencing at the centre, ending at the circumference. Such leaf-blades, it is almost needless to say, are widest at the extremity, since that is the portion which receives most light; often the blade is roundish, and placed at the end of a bare leaf-stalk, which pushes it further and further from the centre, as other leaves arise. Such arrangements are well seen in many of our biennial plants. During their first season they form a close leaf-rosette of this kind, which manufactures during the summer and winter a supply of plant food to be stored for the building up of the



Winter leaf-rosette of the Sea Stork's-bill.
From a photograph by Mr. H. J. Seymour.

tall flowering stem of the succeeding year. The Stork's-bills (*see* figures), Crane's-bills, Teazel, and other plants will occur to the reader as examples.

In the case of a few British plants, the normal position of the blade of the leaf is not horizontal, but vertical. The Black Poplar and its relation the Aspen furnish well-known instances. If we examine the stalk of an

Aspen leaf we notice that while the lower part of it is circular in section, the part near the leaf is much flattened, permitting free movement in the plane of the leaf-blade. This, together with the position in which the leaves are borne on the twigs, causes the leaves to hang vertically. One result is that the light can stream almost unbroken through the branches even to the ground below, the wealth of foliage producing but a faint tremulous shadow as the leaves rustle in response to every breath of air. Well does Scott, seeking for a simile, say in *Marmion*:—

> "Variable as the shade
> By the light quivering aspen made."

A peculiar point about these vertical leaves should be noted. In discussing the question of plant-food in Knowledge last year, Mr. Pearson explained the important functions fulfilled by the leaves; how on the under side of leaves are situated a myriad of tiny openings (*stomata*, mouths) through which the plant absorbs carbon dioxide from the atmosphere, and having taken from it the carbon, liberates the oxygen, the stomata being also used for the escape of the surplus water of the plant. Now, the reason why these mouths are situated in most plants on the under side of the leaves is no doubt because they are thus protected from cold and rain and storm, and their work less interfered with. In the Aspen, with its vertical leaves, either side of which is equally exposed to atmospheric vagaries, there is nothing to choose between the two sides as regards the position of the stomata, and as a matter of fact, these are equally distributed over both sides of the leaf. A further modification of this kind we may find in plants like the Water-lily, the leaves of which float on the surface of water. Following out our line of argument, we would expect to find the stomata confined to the *upper* side of such a leaf, so that they may be in contact with the atmosphere, and this is exactly what we do find. Plants whose leaves are all continually below the surface of the water, such as the Water Lobelia and many Pondweeds, must perforce be content with obtaining the carbon dioxide which they require from the small quantity of that gas which is to be found dissolved in the water.

The protection of leaves against various hurtful agencies next claims our attention. The typical leaf has its upper surface built of strong closely-placed cells, to offer a stout resistance to rain and hail, and to frost or overpowering sun-heat. In hot dry weather, when great evaporation is taking place, the plant can close up all its stomata—shut down, so to speak, all the sluices by which the water employed to convey dissolved salts from root to leaf is allowed to escape, and thus retain an abundant water-supply in spite of parching heat. But in arid ground, such as sandy wastes or sea-beaches, further protection against over-transpiration may be desirable, and this is frequently effected by impervious varnish-like layers on the upper surface of the leaves, or by dense coverings of hairs. Layers of impermeable corky cells in the epidermis or skin of the leaves are also frequently to be found in plants liable to excessive transpiration. Such impermeable leaves are beautifully developed in plants like the Stonecrops, which, growing in dry ground and on rocks, and being liable to long-continued drought, store up in their leaves a copious water-supply. Such reservoir-leaves are greatly developed in the plants of desert countries. Protection against the often fatal effect of frost is likewise afforded by a thickening of the cuticle of leaves, and especially by felt-like coverings of hairs. In some noteworthy cases protect[illegible] effected by means of movement on the pa[illegible]. The most familiar examples occurr[illegible] sensitive plants are furnished by the [illegible] of the Clover family. As evening appr[illegible] and their allies fold their three [illegible] of an upward movement; the position [illegible] retards loss of heat, and the vertical position [illegible] they thus assume has the same effect, tending to check the radiation of heat to the cold sky overhead. The Wood Sorrel, which, though of a quite different order, has leaves which resemble those of the Clovers, effects the same object by folding its leaflets *downwards*.

Wet, which by lying on the leaves might hinder transpiration, must also be guarded against; a danger which in many species is obviated by means of a waxy excretion, especially on those parts of the leaves where the stomata are situated, on which, as on an oily surface water will not lie.

Another danger to which plants are exposed, and one which we might think they would be powerless to meet, is the attacks of browsing animals—animals of all sizes, from minute insects up to great munching cattle. But to note how perfectly such defence may be provided for we need only look at our common Gorse, which boldly invades the pasture, protected by its impenetrable chevaux-de-frise. This plant, indeed, seems to have put so much of its vital energy into the production of spines, that it has none left with which to produce leaves, and as already remarked, the making of plant-food has to be carried on by the green and much-branched stems. The beautiful tribe of the Thistles naturally comes to our minds in this connection. Armed with innumerable spines of the most exquisite structure, sharper and more delicate far than needles, the Spear Thistle and Marsh Thistle raise their tall and graceful forms untouched amid the close-browsed herbage, and without fear of molestation save from man [illegible] his implements of iron—open their flower-heads to the sun and the insects and scatter their numberless [illegible] fruits to the wind. In the Thistle the spines [illegible] borne alike on the stems, leaves, and involucres or outer whorls of the heads of flowers. The Holly is an interesting case. In low bushes the edges of the leaves are provided with strong

Winter leaf rosette of the Hemlock Stork's-bill.
From a photograph by Mr. H. J. [illegible]

spines; but when the bush grows into a tree, and bears leaves far above the reach of browsing animals, the unnecessary spines disappear, and the edges of the leaves are entire. In the Blackthorn and Hawthorn, the strong spines are modified branches; and we may observe that they are much more numerous in young plants than in old bushes. A more complicated mode of protection is found in the Nettles. They are furnished with hollow hairs, filled with a virulent fluid, and bent at the tip. A slight pressure causes the curved extremity to break across, leaving a slender tube, tapering to an extremely fine point, which easily enters the flesh and discharges a portion of its venemous contents.

So far we have considered leaves as fulfilling their normal functions of producing plant food by means of chlorophyll cells. In conclusion, brief reference may be made to various exceptions; for the production of plant-food is not necessarily carried on by leaves, nor is the use of leaves altogether limited to the production of plant food. First, leaves may be dispensed with, as we have already seen in the case of the Gorse. The stem may be modified to supply the place of leaves, as in the Butcher's Broom, whose flattened "leaves" are really branches, as we see when we find flowers and fruit borne on these flat leaf-like structures. In climbing plants the leaves, or a portion of them, are frequently converted into tendrils, often endowed with a marvellous sense of touch, for grasping supports and thus aiding the plant in its upward climb through surrounding herbage to the light. This is seen in many of the Vetches, the upper end of whose leaves are modified in this fashion. In the Yellow Vetchling (*Lathyrus aphaca*) a further modification has taken place. The whole leaf is converted into a tendril, while the stipules (the usually small pair of leaf-like appendages that often grow at the point where a leaf joins a stem) are enlarged into a very respectable pair of "leaves," and manufacture food while the true leaf helps the plant to climb. Of other much stranger modifications of leaves Mr. Pearson has written in KNOWLEDGE last year, Vol. XXIII., pp. 245-6—of the marvellous tentacles which the leaves of the Sundew bear, which catch and digest insects; and how certain leaves of the Bladderwort are converted into snares on the most approved rat-trap plan, for the same purpose—some of the most marvellous fairy-tales of botany.

NOTES.

ASTRONOMICAL.—The recent observations of Eros have resulted in the remarkable discovery that the planet is probably accompanied by a satellite nearly as large as itself. The first indication of this fact was the detection, by Dr. Oppolzer, of variability to the extent of about a magnitude in the luminosity of the planet in the period of a few hours. Confirmation of the variability has been obtained by two French astronomers. M. F. Rossard found the magnitude to range between 9·3 and 11·0 on February 14th, 15th, and 16th, and concluded that the period was 2h. 22m. M. Ch. André believes that his observations indicate a period of about six hours, and states that the light-changes are similar in character to those of the well-known variable U Pegasi; the system being probably composed of two asteroids, with diameters in the proportion of three to two, the plane of revolution passing through the earth. As the inclination of the plane of revolution to the line joining Eros and the earth changes, corresponding differences in the variability may be expected.

There is every indication that adequate records of the total eclipse of the sun on May 18th will be obtained, if the weather should fortunately be favourable. Mr. and Mrs. Maunder will be stationed in Mauritius, where they will work in conjunction with Mr. Claxton, the Director of the Royal Alfred Observatory. In Sumatra, where the duration of totality on the central line is over six minutes, there will be quite an army of astronomers, including Mr. Dyson, of Greenwich; Mr. Newall, of Cambridge; parties from the Lick, Yerkes, and Washington Observatories, and a Dutch expedition under the direction of Dr. Nijland. Photographs of the corona on a large scale, to show the details near the sun's limb, and on a smaller scale to depict the streamers, will be attempted, in addition to spectrum photographs with slit spectroscopes and prismatic cameras.

An extensive comparison of sun-spot and magnetic data which has been made by Father Sidgreaves, supports the view that the distinct connection disclosed cannot be due to a direct action of the sun upon the earth, but rather that there is a common cause for both. Large sun-spots are frequently unaccompanied by magnetic storms, and the cause therefore does not always affect both the sun and the earth at the same time.

The discovery of sixty-four new variable stars is announced in Harvard College Observatory Circular No. 54, a large proportion of them having been found from the presence of bright hydrogen lines in their spectra. Many stars whose spectra are of the fourth type also prove to be variable. These variables have been divided into two classes. First, those in which the variation is so great that it is obvious to the most inexperienced observer. Secondly, those in which the variation so far detected is small, about half a magnitude to a magnitude. In each of these cases, two or more experienced observers, who are accustomed to accurate measures of photographic brightness, are satisfied that the change is real.—A. F.

BOTANICAL.—Under the heading "Economy in Nature," in *Torreya*, a new publication of the Torrey Botanical Club, Mr. P. A. Rydberg mentions a cherry tree which, till quite recently, grew in New Orange, New Jersey. It had an unusually thick trunk, which divided at about seven feet from the ground into two trunks. At the junction of these was a large hole, showing that the stem was decayed and hollow. A strong wind tore away one of the trunks, when it was found that the hollow stem was partly filled with refuse, consisting of decayed cherries and leaves. Into this a stout root, originating from the margin of the hole, had grown, and had then sent off numerous branches into the decaying stem of the tree, which was thus actually preying upon itself.

Brachystelma Bingeri, a new Asclepiad with an edible tuber, is described and figured by M. A. Chevalier in the *Revue des Cultures Coloniales* for February 5th. It is a native of the region of the Upper Niger. The tuber resembles in taste the Jerusalem artichoke, and though only slightly nutritive, its value as a food is augmented owing to the fact that it can be procured when supplies of rice and millet are exhausted. Other species of

Brachystelma, and a *Ceropegia*, are cited, all of which possess edible tubers.

The *Comptes Rendus* for February 11th contains an interesting paper by M. Bernard, entitled "Sur la tuberculisation de la Pomme de terre," in which it is shown that the potato-tuber is produced by the action of a fungus, *Fusarium Solani*. This fungus is always present in the tubers, whether healthy or diseased, and attacks the growing subterranean stems, inducing, it is supposed, the arrest of their growth and the development of the tubers. —S. A. S.

CYCLONES.—At the meeting of the Royal Society of Edinburgh on March 4th, Mr. John Aitken, F.R.S., contributed some additional notes to his paper on "Dynamics of Cyclones and Anticyclones," read a year ago. He was of opinion that cyclones are found over those parts of the earth where there is a high temperature. The movement of the storms in our own area is in a north-easterly direction, because the winds on the north-west side of the anticyclones were generally stronger than those on the other sides. The cyclone is formed out of air from the south travelling towards the north and rotating at a greater rate of velocity than the surface of the earth. He asked: "What is a cyclone?" and answered his question by saying that it is caused by hot air ascending and drawing in air all around it, that it is formed by the anticyclone, and that it is on the north-west side of the anticyclone that we get the strongest winds. The general theory is that a cyclone is not an independent power at all, but is simply a large eddy produced by the action of two anticyclones. Cyclones may be divided into convectional and dynamical, and the distinction may be explained in this way. If the cyclone is convectionally driven, the currents move towards the centre, but if dynamically driven they will move spirally outwards. The exhaustive investigations made at Washington show that the general tendency is inwards, and, further, that in convectionally-driven cyclones the velocity increases towards the centre, but when dynamically driven the velocity does not increase. Mr. Aitken also spoke of the great storm tracks from America, the one passing to the north of the British Isles, and the other to the south; and of how at certain seasons the one moved southwards and the other northwards, and so decreasing the intervening space and *vice versâ*. However powerful an anticyclone might be, a vast amount of energy is without doubt developed in the cyclone itself; but the cyclone is governed to a very large extent by the anticyclone. At Washington it is held that the anticyclone is much the more powerful of the two. It has also been ascertained that they sometimes extend to 6½ miles, although formerly it was thought they were much thinner. Professor Dobbie held that a cyclone was a vast eddy between two currents—the polar and the equatorial—but that view is somewhat modified now. In all cyclones one side is dry and cold, and the other moist and warm; the reason being that the cyclone sweeps before it all the warm surface air and brings down in its wake higher, and therefore drier and colder, air. As there is greater violence of winds in cyclones than in anticyclones, there must be some strong source of energy in the cyclonic areas. It is still evident that to a great extent "the wind bloweth where it listeth, and no one can tell whence it cometh and whither it goeth," as was said two thousand years ago. Yet, as Mr. Aitken has been able to calculate the particles of dust in the air, which were considered to be "numberless," he may yet be able to lay down some sound general laws for the regulation of the cyclones and anticyclones to which he has for some time been giving his valuable attention.—J. G. McP.

ENTOMOLOGICAL.—Professor Wheeler's observations on American "driver" ants and their "guest" beetles (mentioned in KNOWLEDGE for February, pp. 32-3), have been followed by the publication of a valuable paper on the same subject by Father Wasmann, in the *Zoolog. Jahrb.* (*abt. f. Syst. u.s.w.*), XIV., 1900, pp. 215-289, pls. 13, 14). The inquilines described in this paper are rove beetles (Staphylinidæ). A new genus, *Ecitogaster*, found in the nests of a Brazilian *Eciton*, is believed to live in complete harmony with the ants and to be fed from their mouths. In return the beetles provide their hosts with an oily food-substance secreted by fat-cells beneath the cuticle of the abdomen. *Ecitogaster* is quite unlike the ants in appearance, but the beetles of another new (allied) genus, *Ecitophya*, closely mimic the large workers of *Eciton foreli* (in whose company they live), not only in form (*see* p. 33 *ante*) but also in colour. These workers have simple eyes, and presumably therefore a colour-sense. The African driver-ants (*Anomma*) harbour guest-beetles referred to a new genus *Sympolemon*, which seem to bear the same relationship to them as *Ecitogaster* to *Eciton*. A very wonderful adaptation in these beetles is the presence of two deep longitudinal grooves on the forebody shield (pronotum), affording hold for the mandibles of the ants and enabling them to carry the beetles with them on their expeditions. Comparing the guest-beetles of the driver-ants in the Neotropical and Ethiopian regions, Father Wasmann points out the analogy between the types of inquiline which have been developed both in the Eastern and in the Western Continent. Comparing the guest-beetles of the South American with those of the North American *Ecitons*, he concludes that the symbiosis is less highly developed in the latter, and that the beetles have not therefore accompanied their hosts from the south, but have adapted themselves to an inquiline life since the ants immigrated into North America.—G. H. C.

ZOOLOGICAL.—The shoe-bill or whale-headed stork (*Balæniceps rex*), ever since its discovery by Mansfield Parkyns on the White Nile in 1849, has excited great interest. In 1860 Petherick brought home two live specimens, which were exhibited in the Zoological Gardens and attracted much attention by their singular aspect. Outwardly the bird is chiefly remarkable on account of its enormous bill, which is shaped somewhat like the head of a whale, hence one of its names, but it is in other respects distinctly weird-looking, having a gaunt grey body, long legs, and a large head surmounted by a little curled tuft, and a scowling expression of the eyes. It has many structural peculiarities which anatomists have had few opportunities of examining owing to the great rarity of the bird in collections. The British Museum, for instance, up to a few months ago only possessed one skin. The bird itself is sufficiently numerous in the great marshes of the White Nile south of Fashoda, but it is extremely shy and difficult of approach. Since our reconquest of the Soudan several specimens have been obtained on the tributaries of the White Nile, while just lately Sir Harry Johnston has sent to the British Museum a specimen of the bird shot at Entebbe, on the north shore of Lake Victoria, East Africa. Great interest attaches to this specimen, which is now on exhibition in the British Museum, because hitherto the only known locality for the shoe-bill was the White Nile, to which river it seemed to be entirely confined.

At a recent meeting of the Linnean Society, Prof. E. Ray Lankester read a paper on the systematic position of *Æluropus melanoleucus*, with notes on its osteology by Mr Lydekker. The animal in question is an inhabitant of eastern Tibet, and has hitherto been very generally regarded by English zoologists as an aberrant kind of bear, distinguished by its black and white coloration, and the peculiar structure of its teeth. The author now showed that it is really a near relation of the panda (*Ælurus fulgens*), of the Eastern Himalaya, with which it agrees very closely in the structure of the skull and limb-bones. Both animals may now be regarded as members of the, otherwise, American family Procyonidæ (raccoons), of which they will form an aberrant group. For the true panda the name of Himalayan, or long-tailed panda may be adopted, while for the other animal the title of great, or short-tailed panda will be appropriate.

The origin of mammals, as deduced from a study of the occipital condyles of the skull, forms the subject of an important paper communicated by Professor H. F. Osborn to the *American Naturalist* for December. In reptiles the condyle by which the skull articulates with the vertebral column is single, although composed of three elements, whereas in amphibians and mammals the articulation is formed by a pair of condyles. Nevertheless, according to the author, it is the tripartite reptilian condyle which, by the loss of its median element, has given rise to the paired mammalian condyles. Hence mammals trace their descent to reptiles.

WHERE FOUR MOUNTAIN RANGES MEET.

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

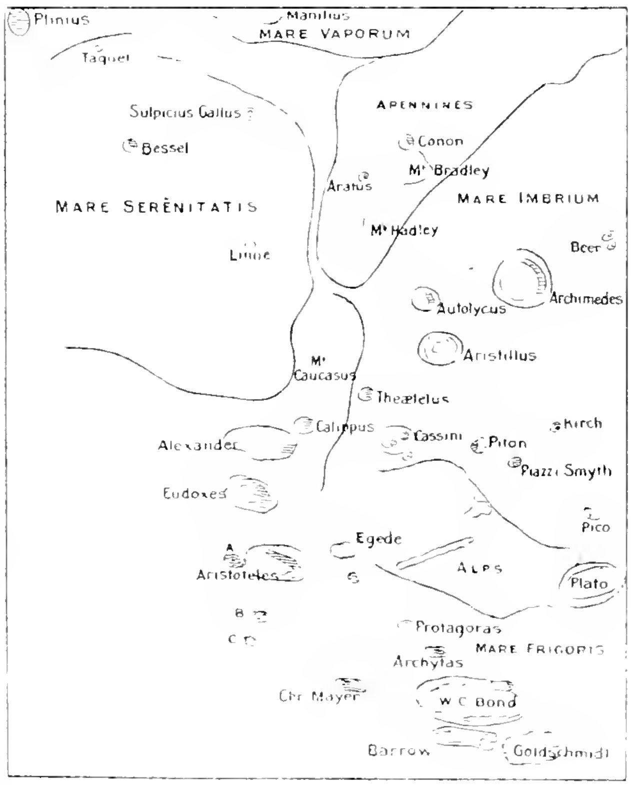
The negative from which the accompanying plate is derived was taken by MM. Loewy and Puiseux at the Paris Observatory, on September 19th, 1894. To the left lies the deep Mare Serenitatis, whose western border is already in night, and to the right is seen a portion of the Mare Imbrium, the greatest of all the lunar seas. Bordering upon and separating the two lunar seas are the four great mountain ranges of Haemus, the Apennines, the Caucasus, and the Alps. The Sea of Cold lies to the north of the Alps, and beyond that again, bordering on the lunar pole is a mountainous region containing many large but little known ringed plains.

The grazing illumination on the terminator shows up well a characteristic feature of the Mare Serenitatis. This is a ramified welt-like structure, whose main ridges lie roughly along the meridian. The effect on the floor of the sea is like the swollen veins on the temple of an angry man. On these ridges the craters, as a rule, seem to lie; thus Bessel is on the crossing of two such ridges, but the effect given is not that the ridges spring or radiate from the craters, but rather that the craters are incidents in the trend of the ridges. A crater does not seem to modify the ridge even in its immediate neighbourhood, nor to alter its course. It is otherwise when the ridge enters the Alpine range, or rather the range of mountains that is manifestly of the same formation as the Alps, which lie to the east of the Caucasus. Here the great ridge, on which Bessel lies, and which can also be faintly traced south as far as Menelaus, is abruptly transformed into a trench, a long straight even valley cutting through the rugged highlands, in a direct prolongation of the ridge that lies on the floor of the Sea of Serenity. The Haemus mountains lie too close to the southern edge of the picture for us to trace whether a similar transformation takes place beyond Menelaus, but other like instances can be traced in this plate in the Alps—notably a bright ridge from Egede A, in the Sea of Cold, runs as straight as rule could draw it into the great valley of the Alps.

Besides the ridge on which lie Bessel and Menelaus, there is another great system which in the present photograph seems to outline the Mare Serenitatis to the west. The sea, however, extends some distance in a still more westerly direction, but this portion is in the darkness of after-sunset.

Although the Mare Imbrium is closely connected with the Mare Serenitatis by the wide and deep pass that divides the Apennines from the Caucasus Mountains, its western portion, which is shown in the photograph, differs in all its characteristic features from the deeper sea. It is not only that it contains such huge ringed plains and craters as Archimedes, Autolycus, Theætetus, Aristillus and Cassini, the smallest of which is a giant compared with Bessel, the chief in the Sea of Serenity; but the influence of these craters on the floor of the sea has been very marked. The floor to the south of Archimedes is rugged and heaped up for a space four or five times the area of the ringed plain itself. From Aristillus broad high ridges extend to the four surrounding craters, and round Autolycus there is a series of brightly illuminated aureoles.

Like two fortresses, Autolycus on the east and Linné on the west stand guarding the broad deep pass before-



mentioned, which divides the Apennines and the Caucasus. Autolycus lies about twice its own diameter from the entrance to the pass, but the western portion of its "aureoles" abut on the outlying boulders of the mountain ranges. In the very entrance to the pass there is faintly seen a semi-circular rampart, like an almost submerged Cassini whose eastern half has been pressed down and covered over by the invading "aureoles" of Autolycus. On the western side, Linné preserves the same distance from the pass that Autolycus does on the east, and here again we seem to see, but more faintly still, the indications of an early ringed plain almost stamped out by the influence of Linné. This region is the more interesting from the suspicions of change in it since it was observed by Riccioli.

Only a portion of the Mare Imbrium is seen in the photograph, that including the Palus Putredinis and the

SOUTH

WEST

NORTH

WHERE FOUR MOUNTAIN RANGES MEET.

Palus Nebularum. The first is seen as a rather shallow depression, stretching from Archimedes south-west to the Apennines, and cut off from the rest of the sea by the high rugged ground that seems to have overflowed from Archimedes on the south, and by the "aureoles" of Autolycus on the north. The Palus Nebularum lies north of Aristillus, and is bounded by the ridges which connect that great ringed plain with Autolycus on the south and with Cassini on the north.

The Sea of Cold is too much foreshortened for the detail on its floor to be clearly made out. It would seem to resemble the Sea of Serenity rather than the Sea of Rain, and the position of Egede A on its intersecting ridges certainly seems to recall the position of Bessel.

Distant as Autolycus, Aristillus and Cassini are from the Caucasus mountains, they yet seem to have exercised some local influence on them. MM. Loewy and Puiseux point out that if lines are drawn parallel to that from Autolycus through the great pass, through the centres of Aristillus, Theætetus, Cassini and Eudoxes, these lines will all lie along depressions in the mountain range. Another feature that they point out is the deep depression that occurs at the outside base of the craters and of the mountain ranges. This is well seen round Archimedes, along the base of the Alps west from Plato, both on the north side and on the south, and most markedly on the eastern side of the Caucasus where it crosses the Alps, and distinctly, though less markedly, on the western side. These two depressions in the meridian line crossing the five depressions which pass through the great craters of the Sea of Rain, and through Eudoxes, divide up the Caucasus range into four great rectangles, and the mountains north of Eudoxes are so divided from the rest of the range that they appear but as isolated peaks.

The two most important and most beautiful ringed plains shown on the photograph are those of Archimedes and Plato. Of nearly equal size, both have the same regular almost unbroken rampart, both have their interior plains but slightly depressed, but the floor of Archimedes is brilliant, and the curious dark bands as it crosses the meridian at right angles are easily seen. The floor of Plato, on the other hand, is very dark, and no detail can be made out in this photograph. MM. Loewy and Puiseux attribute the bands on the floor of Archimedes to the influence of the two large adjacent craters, some pointing towards Aristillus and some to Autolycus. Plato, the "Black Lake," as Hevelius called it, is the best example of those plains which become relatively darker as the age of the moon increases.

CONSTELLATION STUDIES.

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

IV.—BOOTES AND HERCULES.

Three bright stars rule the northern heavens, three stars so equal in magnitude that our highest authorities differ as to the order in which they should be classed in brightness. All three are above the horizon in the April midnight, but whereas Vega and Capella are comparatively low down in the east and west respectively, Arcturus is now approaching the meridian.

Arcturus is one of the easiest stars to recognise in the entire sky. If we start from the Pole Star, we find that the last star in the Plough Handle is just halfway to Arcturus; or the curve of the three stars of the handle of the Plough, if continued, seems to bring us round to the same place; or reverting to our two last studies, Denebola of Leo and Spica of Virgo and Arcturus mark out a triangle, almost equilateral.

The star owes its name [illegible] to the Bear. It is Arcturus, the "Watcher [illegible] Bear." It is now the brightest star in the constellation [illegible] the Herdsman, but in the catalogue of Ptolemy [illegible] in the actual figure, but is an "unformed" [illegible] before him. There seems to have been some [illegible] confusion, for Theon and Hesychius call Bootes [illegible] when Arcturus is excluded, the principal [illegible] the constellation make up a representation, [illegible] it is true, but a representation for all that of the most glorious constellation of the sky. This circumstance may explain an allusion in Isaiah xiii. 10, which has puzzled many commentators, "The stars of heaven and the constellations thereof." The word "constellations" is in the plural, and is the same word which is in the singular in Job ix. 9, Job xxxviii. 31 and Amos v. 8; and which is in each case translated with great probability "Orion." Here then it may stand for the two Orions, Bootes being one. However this may be, the resemblance between the two constellations will be near enough to help the student to trace out the figure. Arcturus stands nearly midway between the Herdsman's two legs, marked respectively by the stars Eta and Zeta; above Arcturus are the three belt stars, Rho, Sigma, and Epsilon, Epsilon being much the brightest. Above we find Gamma and Delta marking the shoulders, whilst Beta takes the place of the cluster of small stars which denotes the head of Orion.

Arcturus and Gamma form two points of an equilateral triangle with Epsilon in the centre; the third point is formed by Alphecca, the Broken Platter. The reason of the name is readily seen, since right and left of Alphecca are four other stars, two on each side, making up a semicircle, and suggesting to the old Arabian star-gazers a broken plate held out by a beggar to receive alms. This very sordid title contrasts poorly with its classical name,

> "That Crown which Dionysos placed
> Of Ariadne dead, a glorious sign."

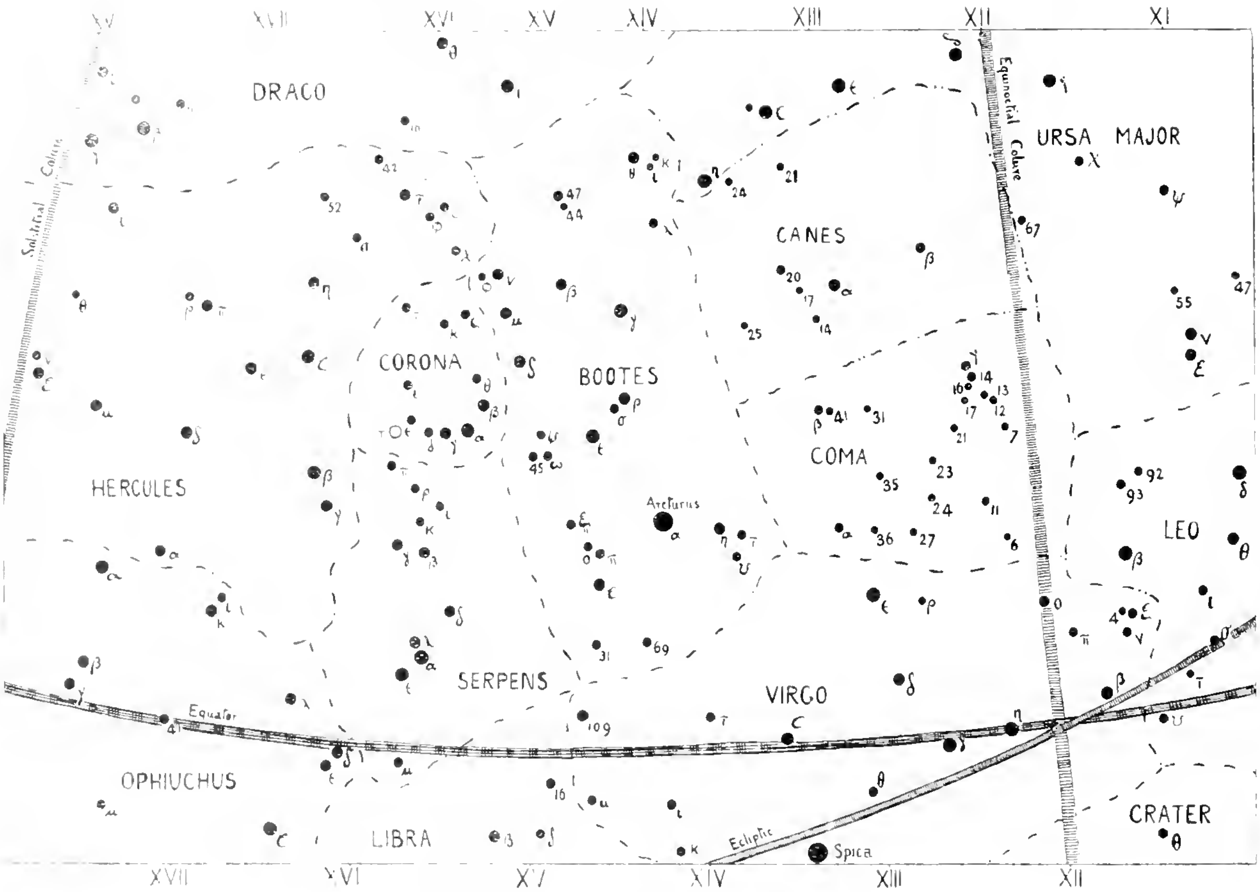
The constellation though so small is, from its shape and its nearness to Arcturus, very easy to find. Or the old rhyme may guide us if we turn back to Virgo, and pick out Epsilon, the "Herald of the Vintage."

> "From Epsilon in Virgo's side Arcturus seek and stem.
> And just as far again you'll spy Corona's beauteous gem
> There no mistake can well befall e'en him who little knows—
> For bright and circular the Crown conspicuously glows."

The small size and neat arrangement of Corona make it a pretty object for the opera-glass; and in 1866 it afforded a grand chance for the naked-eye observer. For on the night of May 12th in that year, the constellation suddenly presented an unwonted shape. Epsilon, the star of the five furthest to the east, was overshadowed by a new and bright companion which outshone Alphecca. This was T Coronae, the first "new star" to appear since the invention of the spectroscope. Less brilliant than the new star in Perseus which has so suddenly blazed out upon us, it created, as the first example of the kind that had occurred in the new era of astronomy, an even greater sensation; and the discovery in its spectrum of the bright lines of hydrogen aroused the utmost [illegible]. Six novæ have appeared since the date of T Coronae, including the one so recently discovered by Dr. Anderson. So far however, as the relatively meagre observations of its spectrum changes go, they seem to point to T Coronae being a nova of a different kind from those which have succeeded it.

A line from Gamma Bootis through Theta Coronae, the most westerly of the five stars of the "Broken Platter," brings us, at an equal distance beyond, to Beta in the constellation of the Kneeler. This is not a brilliant constellation, having no stars so bright as the second magnitude, but it can be pretty easily traced out. Taking Beta and the somewhat fainter star Gamma, just below it, as the root, the stars map out the calix of a gigantic lily: Gamma, Beta, Zeta, Eta, Sigma and Tau, six stars in a beautiful curve, sweeping round the little constellation of the Crown, forming the western outline of the flower. Hercules is the name now universally ascribed to this the current outlines of the constellations, regarded as making the true Dragon's Head.

The third curve of the great lily of Hercules extends from Gamma and Beta, through a well marked line of stars, Delta, Lambda, Mu, and Nu, to the little constellation of the Lyre, the principal star of which is the great blue brilliant Vega, the worthy rival of Arcturus and Capella, if not superior to either. The



Star Map No. 4; The Region of Bootes and Hercules.

constellation, but the name was foisted upon it in comparatively recent times. Aratus sings:—

"A labouring man next rises to our sight,
But what his task or who this honoured wight
No poet tells. Upon his knee he bends,
And hence his name, Engonasin, descends.
He lifts his suppliant arms and dares to rest
His right foot on the scaly dragon's crest."

The first suggestion that this Kneeler was the great national Hellenic deity, seems to have been due to Panyasis, the uncle of the great historian, Herodotus. In a poem on the subject of the great national hero, in order to do him the greater honour he sought to identify him with the unnamed wrestler of the constellation. The fact that despite this effort the identification had entirely failed of adoption 200 years later, is as near positive proof as we can get, not merely that it was not known whom the constellation represented, but that it was known that it did not represent Hercules.

The second curve of Hercules runs through the stars Gamma, Beta, Epsilon, and Pi and Iota: Iota making a diamond with the three stars in the Head of the Dragon, Beta, Gamma and Xi. This diamond, Proctor, in his ingenious but usually quite unauthorised alterations of brightness and the intensely blue light with which it shines render Vega a very easy object to pick up, but if an alignment is required, a straight line from Arcturus through Alphecca to Zeta Herculis leads almost straight to it, Zeta being halfway.

"There is the Shell but small. And this, whilst yet
Encradled, Hermes pierced and called it Lyre;
Fronting the Unknown Form" (*i.e.*, the Kneeler) "he set it down
When brought to Heaven."

The principal stars of the constellation are very easy to recognise. Vega forms one of the points of a little equilateral triangle, the other two angles of which are occupied by Epsilon and Beta. Epsilon is to very keen sight a naked-eye double: the opera-glass separates the two stars at once, and no great telescopic power is required to show each star as itself a neat little pair. Zeta marks also the upper angle of a little rhomboid, of which Beta, Gamma, and Delta mark the other angles. Each of these stars is an easy double for the opera-glass: Nu and Lambda being companions to Beta and Gamma respectively. Beta is one of the most interesting of short period variables; its period being two hours short of thirteen days, in which time it passes through two maxima and two minima, the minima being, however, of unequal brightness; but as even when faintest it is of magnitude 1½, it is always well within the grasp of the naked-eye observer.

The Milky Way flows across the S.E. angle of the constellation, and this, with its dazzling leader, its numerous pairs, its beautiful fields and wonderful variable, renders it a fine region for the opera-glass observer. To the naked-eye astronomer, it is also noteworthy as the home of the swift meteors of April 20th—the Lyrids—their radiant point being just on the boundary line between Hercules and Lyra.

The constellation is always shown now as an eagle with a harp slung round its neck, and the name of the principal

The Midnight Sky for London, 1901, April.

star, Vega, refers to this design, since it comes from the last word of the Arabic expression, *Al nesr al waki*, the "falling" or "swooping eagle"; in contrast to Aquila, the principal star of which we now call Altair, that is to say, *Al nesr al tair*, the "flying," that is, the "soaring eagle."

The head of Hercules is marked by a beautiful orange coloured star, Alpha Herculis, Ras al gethi, the "head of the Kneeler," forming the southernmost point of a lozenge of which Beta, Zeta and Delta Herculis are the other three points. Alpha Herculis is notable in the spectroscope as presenting one of the finest examples of the third or banded type of spectrum.

Notices of Books.

"A Text-Book of Zoology, treated from a Biological Standpoint." By Dr. O. Schmeil. Translated by R. Rosenstock, and edited by J. T. Cunningham. Part III. (A. and C. Black. 1900. Price 3s. 6d.—The two previous parts of this work were noticed in our November issue, where reference is made to the general scope of the work, and the class of readers for whom it is intended. The present part, which treats of Invertebrates, completes the work. Were it not for the unaccountable omission of certain most important groups, such as the Brachiopods and the Tunicates, not to mention that most remarkable worm *Balanoglossus*, we should have been enabled to bestow higher commendation on this portion of the work than, as matters stand, we feel justified in doing. If, however, we discount these omissions, there is little doubt that the subject as a whole is treated in a satisfactory manner, and in a way which can scarcely fail to p[illegible] the pupil. A[illegible] in the earlier parts, atte[illegible] on physiology and habits rather than on mere [illegible] [illegible]ptions of the transformations undergone by [illegible] of the marvellous developmental history [illegible] of intestinal and other parasitic worms, are [illegible]. The illustrations, too, are well selected, and [illegible] satisfactory from an artistic point of view. At [illegible] of the descriptive part of the work, two pages are [illegible] to the geographical distribution of animals. While [illegible] many aspects in which it might be amended with advantage, [illegible] as a whole has undoubtedly many merits, and it is [illegible] cheapness.

"The Child: A Study in the Evolution of Man." By A. F. Chamberlain, M.A., Ph.D. (Walter Scott.) Illustrated. 6s.—The sub-title appears to us to express the scope of the contents of this book better than the first two words. The child is described in many of its aspects, but more as a stage in the evolution of man than as a special problem. The book is thus more adapted to the point of view of the student of organic development than that of the kindergarten or other teacher interested in child study. Broadly speaking, the mental stages through which a person passes in the course of a lifetime can be represented by similar stages in the psychological development of a race. Man begins at the very bottom of the ladder, both as regards body and mind, and slowly crawls to maturity. Dr. Chamberlain traces this progress with particular reference to psychological characteristics, and shows how it can be interpreted by the principles of evolution. The book is full of material for reflection, and suggestive ideas, but it might have been condensed to half its present dimensions without losing any of its force. Much of the matter seems to have been included more because it was available than because it was relevant to the subject. A teacher of psychology was once defined by a child as "A man who tells us what everyone knows in language which nobody can understand," and to this we may add that many psychologists elucidate and classify results which are of little value, even when they are understood. Take, for instance, the drawings which are often described and illustrated as representing the ideas of children. Such sketches of course do not show the images the child wishes to portray, but the movements of a hand as yet unable to trace the workings of the mind. A similar criticism may be applied to the answers which some psychologists are fond of obtaining from children, with the view of determining the course of mental development. However, Dr. Chamberlain deals with many other matters, and his book contains much that is interesting concerning normal and abnormal man, from childhood to old age.

"Botany, an Elementary Text for Schools." By L. H. Bailey. (New York: The Macmillan Company.) 1900. Illustrated.—With a clearer understanding of the importance of scientific methods of elementary teaching, there has arisen a demand for elementary treatises which is far from being satisfied by the works with which, in many branches of science, teachers have still to rest content. We have no hesitation in saying that Prof. Bailey's elegant and beautifully illustrated volume approaches nearer to our ideas of what a school-book of Botany should be than any that we have hitherto met with. No one doubts now that the beginner should approach the study of plants in the field and not in the laboratory, with hand and eye rather than by the aid of razor and microscope. That the author fully realises this he makes clear in the preface: "The pupil should come to the study of plants and animals with little more than his natural and native powers. Study with the compound microscope is a specialization to be made when the pupil has had experience and when his judgment and sense of relationships are trained." The plant is set forth as a living organism, and the pupil is led to study it where and as it grows. With [illegible] part of the subject the first twenty-five chapters (200 pp.) are concerned. If these chapters are read and illustrated [illegible], they must impart that living interest in living plants [illegible] is essential if the study of Botany is to have the [illegible] educational value which it possesses when directed by a [illegible] teacher. Five chapters are devoted to a consideration of relationships between the plant and its physical and organic surroundings. The economics of plant societies, the great [illegible] interest of which is the outcome of recent research, are [illegible] and clearly considered. In the last six chapters the intimate structure and the classification of plants are dealt with. One of the most remarkable features of the book is the abundance and excellence of the illustrations, many of which are quite unique in a work of this character. It may perhaps be considered that the volume is over-illustrated. Copious representations of Nature in a school-book of Botany are not unlikely to supplant field observations, and thus prove themselves a snare rather than a blessing. We trust that this work is destined to become well known in this country, and therefore the more regret that its usefulness is impaired by the use of popular (American) names of plants which are quite unintelligible to the British reader. The botanical names in brackets would have been of great assistance both to teachers and scholars. These and a few other minor defects do not seriously detract from the excellence of Prof. Bailey's work, which we have read with great pleasure, and can heartily recommend to those who seek a first-class school-book of Botany.

BOOKS RECEIVED.

Practical Organic Chemistry for Advanced Students. By Julius B. Cohen, PH.D. (Macmillan.) Illustrated. 3s. 6d.

Report on the Census of Porto Rico, 1899. (Washington Government Printing Office.)

The A B C of Dynamo Design. By Alfred H. Avery. (Dawbarn & Ward.) Illustrated. 1s. net.

Model Boiler Making. By E. L. Pearce. (Dawbarn & Ward.) Illustrated. 6d. net.

Sartor Resartus. Heroes and Hero-Worship. Past and Present. By Thomas Carlyle. (Ward, Lock.) 2s.

Researches on the Past and Present History of the Earth's Atmosphere. By Dr. Thomas Lamb Phipson. (Griffin & Co., Ltd.) 2s. 6d.

The Child: His Nature and Nurture. By W. B. Drummond, M.B., C.M., M.R.C.P.E. (The Temple Cyclopaedic Primers.) (Dent.) 1s. net.

First Aid to the Injured and Ambulance Drill. By H. Drinkwater, M.D. (The Temple Cyclopaedic Primers.) (Dent.) 1s. net.

The Complete Works of John Keats. Vol. IV. Edited by H. Buxton Forman. (Gowans & Gray.) 1s. net.

Whist Dialogues. By Major Jack Tenace. (Bruxelles: Imprimerie E. Wagemans.)

An Enquiry concerning the Principles of Morals. By David Hume. (Kegan Paul.) 1s. 6d.

The Value of Scientific Training. By Prof. J. Logan Lobley, F.G.S., F.R.G.S. (Cowell.)

The Structure and Inherent Motions of the Universe. By Edward Meyer. (Adelaide: A. & E. Lewis.)

The Photo-Miniature, January, 1901. (Dawbarn & Ward.) Monthly, 6d.

Paper Work. By Rev. F. C. Lambert, M.A., and Charles Godfrey Leland, M.A., F.R.S.L. (Dawbarn & Ward.) 6d. net.

Seventeenth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1895-6. Part II. (Washington: Government Printing Office.)

Catalogue of Chemical Apparatus, &c. (London: Gallenkamp & Co., Ltd.) 2s.

Thornton-Pickard Photographic Specialities. (Thornton-Pickard Manufacturing Co., Altrincham.)

The Norwegian North Polar Expedition, 1893-1896—Scientific Results. Edited by Fridtjof Nansen. Vol. II. (Longmans.) 30s. net.

Letters.

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

SUNSET PHENOMENON.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I think Mr. E. W. Maunder, in his note appended to Mr. McDonald's letter on the above subject, treats the matter possibly a little too cursorily, in stating that the rays are rarely traced right across the sky. In the dry uplands of South Africa, in the brilliant dry weather one gets in winter, I have night after night observed these lovely pink streamers stretching right across the sky, and meeting at a point opposite the sun's position; and I have often speculated as to their origin. They would never be quite the same two evenings running; sometimes there would be several of these rays, well defined, all a beautiful pink, contrasting exquisitely with the pale blue of the twilight sky. Next evening there might perhaps be one huge fan-like one stretching laterally over many degrees of the sky, with one or two narrow ones. I quite admit that they are exactly analogous to the rays of the sun piercing an aperture in clouds which cut off his direct light from the space surrounding the cylinder of atmosphere illuminated directly. But the difficulty always occurred to me, where were the clouds that produced the streamers or rays, because we knew for certain (in the Transvaal where I was then stationed) that in the winter season the whole sky, over an enormous tract of country, was absolutely free from cloud. Those who have lived in the country referred to will, I think, appreciate this question.

I have dwelt on this topic before, in the columns of the *English Mechanic*, and observed I should like to see the subject treated scientifically. Query: At what distance should clouds be situated from the observer to produce the effect of these pink streamers shortly after sunset? Of course the exact time would have to be given, in order to ascertain the depression of the sun, at that time, below the horizon. Also, is it not possible that the rays might be caused by the sun's light passing over ranges of broken hills and mountains which abound in South Africa? The valleys between mountains might admit the tangential rays of the sun, while the mountains would cut them off. I have by me a water-colour sketch of the Magaliesburg Range taken from a spot a few miles distant from Pretoria. The horizon goes up and down, as peak and valley are defined in the clear blue distance, and the gorge where the Crocodile River cuts through the range is sharply marked. Might not such irregularities in districts somewhat beyond the terrestrial horizon be the cause of the pink streamers?

In some cases this phenomenon is no doubt due to clouds, for I find that when at sea, in the year 1885, I noticed a curious effect one evening just after sunset; the left hand part of the sky (looking westwards) was ruddy, while the right was a beautiful turquoise hue. This was undoubtedly only a form, or special case of the pink streamers, but in this case mountains could not be brought in as the cause, as we were at the time far from land; and clouds must have been the cause. In England one does not often see the streamers stretching across the sky, and meeting at the point opposite the sun. I seem to recollect only one occasion.

They usually take the form of a fan, and are so represented in landscapes; sometimes radiating upwards and sometimes downward, the sun being generally supposed to be above the horizon at the time.

This phenomenon is quite distinct from the "pink glows," when the *whole* of the western sky is illuminated with a pink glow, verging through orange to coppery red near the horizon. This is due to either aqueous vapour or fine dust disseminated in the upper regions of the atmosphere under peculiar conditions.

E. E. Markwick (Col.).

Devonport, 10th March, 1901.

"MRS. QUICKLY'S TABLE OF GREEN FIELDS."

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Surely a "table of green fields" is the correct reading. Dame Quickly, whose mind could not soar above the most homely ideas, was thinking (or, rather, Shakespeare was thinking for her) of a map of a country parish, on which the size and positions of its several fields are marked—the map is called a "Terrier" from *terra*—and she meant that Falstaff's nose was so wrinkled and indented with lines as for it to be comparable to such a map. The comparison occurs in at least two other places in Shakespeare, *e.g.*, Maria says of Malvolio (Act III., Sc. 2): "He doth smile his face into more lines than are in the new map with the augmentation of the Indies"; the same idea being presented in Henry IV. (II., [illegible] 1) by "He shall laugh till his face be like a wet cloke ill laid up." Again, in "The Rape of Lucrece":—

"[illegible]
The face, that map which deep impression bears
Of hard misfortune, carved in it with tears."

Also in Titus Andronicus, it is said to the woe-begone Lavinia, "Thou map of woe"; and in another play we have "Thy face, the map of honour." Shakespeare, like other writers, uses the word "table" in the sense of a surface on which something is painted or drawn, *e.g.*, "I beheld myself Drawn in the flattering table of her eye"; and, again, "Who art the table, wherein my thoughts Are visibly charactered and engraved." He also speaks of the (second) table of the commandments. Byron has, rather incorrectly, "A moment o'er his face A tablet of unutterable thoughts Was traced."

Dame Quickly, then, means that Falstaff's erstwhile "jolly red nose" had shrunk and become pointed and wrinkled. H. ALGAR.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Attempts to explain Mrs. Quickly's "table of green fields" have not been so successful as to exclude others.

May I suggest the omission of the "b" in "table," leaving "tale"? JOHN JAMES COULTON.

Pentney, Narborough, Norfolk.
February 22nd, 1901.

A CURIOUS ELECTROGRAPH.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The rather curious negative of which I send a print was obtained in this way. My laboratory was converted for the occasion into a "dark room." A dry plate was laid on a stand without protection of any sort. The gutta-percha covered wires from my Wimshurst machine were placed upon it alternately in positions 1, 2, 3, 4 and 5 as the print shows. The impressions shown in positions 2 and 4 were produced

1 2 3 4 5

by a shilling likewise laid upon the dry plate head downwards. Two sparks were sent through positions 1 and 2, four through positions 3 and 4, and one spark through position 5. I expected to get in the places of the coin impressions of roughly circular blank. The first puzzle then [illegible] in the performance is, how comes it that [illegible] at all. The phalange round the edge of [illegible] unquestionably good. Next, how is it that [illegible] profile is almost equally illuminated in either position. In position 2 it is turned towards the negative [illegible] receives two sparks, in position 4 it faces [illegible] and gets 4 sparks. Without a doubt the general [illegible] of illumination is better in 2 than it is in 4, but it is quite clear that in the former case the wires are farther apart. For some mysterious reason the back of the head in position 4 fails to appear at all.

The glow at the end of the gutta-percha covering of the positive wire is also curious. Why should leakage be more decided there than it is apparently along the course of the uncovered wire? WILLIAM GODDEN.

38, Burrard Road,
West Hampstead, N.W.
January 29th, 1901.

THE NEBULAR HYPOTHESIS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I gather from Sir Robert Ball in his "Great Astronomers," that one of the factors which led La-Place to propound his nebular hypothesis was the fact that all the planets and their satellites (that were then known), comprising some thirty circular movements, travelled and rotated in the same direction in which our earth is known to do, viz., from west to east.

I should be extremely obliged if you could inform me through the medium of your valuable journal, which I have read with such pleasure for the past fifteen years, whether the nebular hypothesis is in any way damaged by the discovery that one or more of the satellites of Uranus travel round it in the opposite direction, viz., from east to west, and can such a diverse movement be accounted for. As this question arose at a Literary Society Meeting, when the nebular hypothesis was being discussed, and remained unsolved of course, I decided to seek information at the fountain head.

H. CHRISTOPHER.

[Necessarily, a theory like the nebular hypothesis can deal only with the facts as we know them at the time, and new facts as they are brought to our knowledge have to be recognised, and it may be that the theory has to be somewhat modified to include them. M. Faye, for instance, in his form of the cosmogonic theory, supposes that the solar system at an early period consisted largely of separate meteorites, which arranged themselves in process of time in flat and nearly circular rings round a small central nucleus. Whilst the nucleus—the future sun—was small, the rings moved as a rigid whole, the outer meteorites of any ring moving absolutely faster than the inner. Consequently when a planetary mass was aggregated out of any ring at this period the tendency of the planet and its satellites was to assume a direct rotation. As the sun grew the tendency in each ring yet uncondensed was for the outer meteorites to move less rapidly than the inner, and hence to form planetary systems rotating retrogradely. Therefore, according to M. Faye, the earth and all the planets up to Saturn are much older than the sun, but Uranus came into being when the two tendencies were about balanced, and consequently its satellites revolve in a plane almost perpendicular to that of the planet's orbit. Neptune would seem to have come into existence later still. It is, however, only fair to point out that there are very considerable difficulties attaching to M. Faye's form of the theory. I give it only as an example of one way in which it has been attempted to explain the fact to which Mr. Christopher alludes. E. WALTER MAUNDER.]

IS HUMAN LIFE POSSIBLE ON OTHER PLANETS

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Referring to Mr. Thomas R. Waring's reply to Mr. A. D. Taylor's query, "Is human life possible on other planets," he states that Mars' atmosphere is thin, and consequently free from clouds. In Wells & Gregory's Honours Physiography, as well as in various other books, it is stated that Mars possesses clouds which are visible in the large telescopes as dark moving patches. I should like to know which of the above is right. If Mars possesses no clouds on account of its thin atmosphere, I should like to know what atmosphere has to do with clouds. E. LLOYD JONES.

Blaenau Festiniog.

[I do not remember the passage in Wells and Gregory's Physiography, but it should be pointed out that clouds on a planet in opposition would necessarily appear as extremely bright bodies, not dark; whilst it is in the last degree improbable that any cloud motions could be perceived. A white spot upon Mars might conceivably be due to snow, hoarfrost, or cloud, and it would be quite impossible for us to discriminate at our immense distance from the planet between the three. On our earth dense and widely extended clouds are confined to the lower regions of the atmosphere. The upper strata, which approximate in tenuity to what we can conceive of the atmosphere of Mars, support nothing but thin cirrus clouds, which could not possibly be discerned as such across 40 millions of miles.—E. WALTER MAUNDER.]

HUMAN FINGER-PRINTS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The constancy of human finger-prints has chiefly been discussed in connection with the identification of criminals. Assuming that the evidence of finger-prints is to be admissible in criminal proceedings, it will be not only necessary to prove that in the case of the same man the finger-prints remain unaltered, but that no two persons have identical finger-prints. Where is the evidence of this? There are probably 1,500,000,000 of men and women on the earth. Can we suppose that no two of these have identical finger-prints? Nor indeed is this all. We may be comparing the finger-prints of a living man with those of one who has been dead for years past, and the doctrine of heredity might lead us to expect to find similar finger-prints in the case of parents and children, and of different children of the same parents. It is, at all events, certain that if this finger-print system were once introduced into our courts of justice, there would be any amount of wrangling as to whether they were identical or only similar—experts contradicting each other and involving the whole subject in confusion. Moreover, professional criminals would probably soon find some mode of altering their finger-prints. No doubt if the person who committed a crime —a murder, for example—has left the imprint of his fingers on anything it may prove an important clue; but the same thing may be said of the imprint of his boots or shoes. But a clue is one thing and a proof is another thing.

Let me point out another difficulty. In a country where there are a large number of criminals whose finger-prints are collected, the number of these will soon be very large. How long would it take to examine this collection in order to find out whether any of them corresponded accurately with the finger-prints of the man who is now accused? The task would, I think, be a hopeless one.

That finger-prints may be important in the detection of crime whenever the criminal has left the print of his fingers behind him I do not dispute, but without much stronger evidence than we now possess that no two persons have undistinguishable finger-prints such evidence ought never to be permitted to outweigh what appeared to be a tolerably satisfactory *alibi*. As to persons guilty of repeated crimes, I do not see the justice of adding to a man's sentence on the present occasion because he has fully expiated a previous offence; while a really habitual criminal can never pose as a first offender under our present system, although some of his previous convictions may be overlooked.

W. H. S. MONCK.

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

EARLY APPEARANCE OF THE DOTTEREL IN YORKSHIRE.—Two Dotterels (*Eudromias morinellus*) were seen here on February 18th, and one again on March 2nd. These are surely extraordinary early dates for this summer visitor, which does not usually reach us until towards the end of April.—PHILIP W. LOTEN, Easington, Yorkshire, March 5th, 1901.

THE LITTLE DUSKY SHEARWATER (*Puffinus assimilis*, Gould) IN SUSSEX. At the meeting of the British Ornithologists' Club, held on February 13th, a communication from Mr. Ruskin Butterfield on the occurrence of a Shearwater of this species in Sussex was read by Mr. Hartert. The bird was picked up in an exhausted condition on the beach near Bexhill during the hard gale from the W.S.W. on December 28th, 1900. Both Mr. Ernst Hartert and Mr. Howard Saunders have examined the bird, and proclaim it to be *Puffinus assimilis*. This species breeds on the islets of the Madeiran group, the Salvages, nearer to the Canaries, and also in the Cape Verde Islands. It is also found in the Australian and New Zealand seas. This is but the third occurrence of the bird in the British Isles, which indeed are far from its normal haunts, and the visits of this bird to this country can only be put down to accident.

Tawny Owl in Ireland (*Irish Naturalist*, March, 1901, p. 72).—In KNOWLEDGE for February, 1901, p. 43, a record of the occurrence of the Tawny Owl in co. Down, Ireland, was [illegible] to, and it was there remarked that the bird had never before occurred in Ireland. It now appears that a gentleman [illegible] Tawny Owls from the New Forest and liberated them in co. Down. This satisfactorily explains the presence of the bird which was shot in the county in November last. It appears also that a number of Jays have been liberated in the same way. The practice of introducing birds or animals foreign to a country and liberating them in that country cannot be too strongly condemned. From a naturalist's point of view such an act is the deepest offence, and is likely to cause almost as much harm to science as the extermination of a species in a country. The movements and geographical distribution of birds and animals is a difficult enough subject as it is without the interfering agency of mankind. What will happen in Ireland through the act of this "gentleman who takes some interest in ornithology"? All the future records of Jays and Tawny Owls in the north of Ireland will be under suspicion, and the study of the geographical distribution of the species as far as this part of the country is concerned will be at a standstill. The introducer, moreover, added to his offence by not informing naturalists of what he had done. Apart from this it would be of interest to know who broke the law in procuring these young birds from the New Forest.

Winter occurrence of House Martin in Yorkshire (*The Naturalist* March, 1901, p. 74).—Mr. T. H. Nelson observes that a House Martin appeared in front of "The Cliffe," Redcar, on December the 14th last, and was seen at intervals, flying to and fro, until the 20th of December. Although, of course, the majority of Martins have travelled south before December, a few individuals, generally young birds, are occasionally seen in December in mild seasons. The above, however, is an exceptionally late occurrence for so far north.

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.***

PRE-HISTORIC MAN IN THE CENTRAL MEDITERRANEAN.

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

It has long been a matter of common belief that the south of Italy and the northern coast of Africa are the remnants of a land barrier which formerly divided the Mediterranean into two basins, and connected the continents of Europe and Africa.

This barrier has existed from early geological times. The nucleus of the Alps and Apennines consists of Jurassic rocks, and prior to the subsidence that ushered in the Cretaceous or Chalk period, a ridge of these rocks extended above sea-level from the north of Italy, through Sicily as far south as the island of Galita off the coast of Tunis.

During Miocene times the ridge formed a portion of the bed of an extensive ocean, and it was then enveloped with a series of limestones and clays of great thickness whose representatives may now be traced in Tunis, Malta, Sicily, Italy, and as far as the northernmost limits of the Vienna basin. The evidences which are offered of the former existence of the central Mediterranean land bridge between the two continents show that during the latter part of the Miocene period the bed of the Mediterranean, together with a large area of southern Europe, were slowly elevated. In the Maltese islands are to be found extensive deposits of Globigerina limestones which were laid down in a sea whose depth varied from one thousand to three thousand fathoms; and these deposits are overlain by a series of marls, clays, and coralline limestones, which were deposited in depths of from one hundred to ten fathoms.

A similar sequence may be traced in Sicily, Italy, and Austria where the series are overlain, in their turn, by extensive deposits of pebbles, sand, and loess of Pliocene age. The Pliocene period was a time of great unrest for the central Mediterranean.

It witnessed [illegible] and the [illegible] of the land [illegible] and Africa. The submergence [illegible] of the greater portion of the M[illegible] and besides forming the [illegible] land down the [illegible] tracts from the Urals to [illegible]

Proofs of these physical [illegible] the sequence of the beds of the d[illegible] contrasts and affinities of the fossil [illegible] of northern and southern forms of animals [illegible] fossil and recent, in the caves and superficial deposits on either shore of the Mediterranean.

The central Mediterranean barrier is now in part submerged, the only visible remnants being Sicily, the Maltese islands, and a few islets off the African coast, but the depth of the submergence is not great, being least between Malta and Sicily, and greatest between Malta and the African coast. An elevation of this portion of the Mediterranean floor to a height of sixty fathoms would re-establish the old continental connection.

The region offers a rich field of research to the geologist, and its problems suggest many interesting questions to the antiquarian. Rude stone monuments, implements, burial places and other records of the existence of primitive man in the area are surprisingly numerous. Within the last twenty-five years attempts have been made to classify the relics that have been found, and to trace out the histories of the peoples who originated them. To a certain extent the work has been successful, but much still remains to be done in the direction of determining whence the people came and the part which the great land bridge between the two continents played in their migrations. Remains of the Neolithic or later Stone Age folk have been found in every part of Sicily. Some of the most interesting were exhumed by Palumbo from a crevice near Caltanisetta, and by Fiorini from the Montagna Grande near Palermo.

In 1890 a series of Neolithic caves was explored at Isnello in the province of Palermo. One cavern was nearly filled with human bones; the remainder contained an abundance of ornaments, stone weapons, and the ashes of cave fires. A cave was discovered in 1891 at Catania, containing the remains of a fire, a collection of mammalian bones, several human jaws, and a number of flint implements.

The origin of the flint offered some difficulty at first as it was not then known to occur in any Sicilian formation. During a journey through Sicily in 1893 I traced it to the limestone deposits in the Val di Noto, and in the ravines at Modica and Ragusa, where it occurs interstratified with bands and concretionary masses of chert or phtanite in the Miocene rocks of the district. Proceeding westward to Sardinia, numbers of artificial caves formerly used by the primitive Sardinian as tombs and dwelling places occur in the sides of the hills and valleys. These caves vary greatly in size and character in different parts of the island, but among the natives they are known by the one name, domus de janas. They are always found in proximity to the megalithic nuraghi, but they antedate these ruins by long ages, and belong at least to the later Neolithic period. The Neolithic races made their first appearance on the Mediterranean shores at the close of the Glacial or so-called Post-glacial period, and no evidence of an earlier existence either here or elsewhere has yet been forthcoming. Their predecessors, the Paleolithic folk, lived in southern

Europe during the later Pliocene and early Pleistocene times, that is, at the period when the greater portion of northern Europe was enveloped in a *mer de glace*.

These people were driven south by the intense cold, and they settled at many points around the Mediterranean. It is an interesting fact that though the remains of the Neolithic races are so plentifully distributed over the central Mediterranean area, no evidences have yet been forthcoming to show that the Paleoliths ever inhabited it.

A probable explanation of the absence of Paleolithic relics in the central Mediterranean region is afforded when the nature of the physical changes that occurred in the neighbourhood at the beginning of the Pleistocene period is taken into consideration. The Pliocene and Pleistocene deposits which envelop the lowlands and flank the highlands of southern France, Italy, Sicily, Malta and northern Africa, as well as the vast work of accretion which Etna has achieved during its comparatively short existence, afford some idea of the nature and magnitude of the forces that have acted on the area. The birth of Etna at the close of the Pliocene period was followed by the breaching of the land barrier which connected Europe with Africa, and its gradual subsidence beneath the invading waters. The changes were slow and tentative, and not of the nature of a cataclysm. The animals and plants of the land barrier were cut off from the mainland, and as their habitats gradually lessened in area so they died off, and left their remains to form the massive ossiferous agglomerates that now fill the caves, fissures, and ravines of Sicily and Malta.

Of the man of this period nothing is known, but it is possible that he recognised the danger of the situation, and, migrating, so escaped the fate which befell the remainder of the animal life of the district. He disappeared as mysteriously as he came, and the *débâcle* that finally swept the area and divided the continents was such as to remove every vestige of the old life, and every evidence of his occupation. His Neolithic successor experienced quieter times, and dwelt under conditions that were favourable to the preservation of his remains. Sicily and Sardinia are not the only places in the central barrier that have furnished evidences of pre-historic races. The Maltese Islands have, of late years, been carefully explored, and have added, if not an important at least an interesting quota to our knowledge of the subject.

In the early sixties the late Admiral Spratt and the late Professor Leith Adams carried on a series of investigations in the islands. The discovery of a stone weapon by Mr. J. Frere, F.R.S., in a garden at Villa Frere, near Valetta, attracted the attention of Adams, and for several years he gave special attention to the question of the occupation of the islands by pre-historic man. Professor Issel of Florence visited the islands in 1868, and, while superintending the excavation of a series of trenches in the Har Dalam cavern at Marsa Scirocco, he discovered, at a depth of four feet from the surface, the remains of a fire together with a collection of burnt mammalian bones and fragments of a coarse kind of pottery. It is to be regretted that for nearly a quarter of a century after the return of Issel to Italy no further steps were taken to follow up this discovery. In the years 1887 to 1894 it was my good fortune to make several additions to our knowledge of the extinct fauna of the district, and to discover further evidences bearing upon the history of the islands' early inhabitants. The more important discoveries were made in the Uied Har Dalam, a gorge which is situated on the eastern coast of Malta, and whose sides are perforated with a series of caves and fissures. The largest of these caves, known as Har Dalam, is more than half filled with a series of stratified floor deposits consisting of alternating layers of loam, ossiferous agglomerate, clay, stalagmite and boulders. These layers are arranged in two well-defined divisions, the lower of which is separated from the upper by a massive layer of stalagmitic conglomerate representing a period of time of considerable duration. In the lower division of the series was found a curious assemblage of jaws, tusks, teeth, and limb-bones of extinct elephants, hippopotami, bears, deer, wolves and giant dormice. In the upper occurred thousands of limb-bones, jaws, teeth, and antlers of deer, together with the remains of horses, dogs, ashes of domestic fires, fragments of a coarse kind of pottery, and the metacarpal bone of a human skeleton. These relics of the Maltese aborigines were found at several points in the cavern, but always at about the same horizon and in the upper division of the deposits. The latter fact is significant, as it agrees with the results of similar researches in Sicily, where no evidences of man have yet been forthcoming from deposits that were contemporary with the now extinct Quarternary mammalia. The different types of animals in the two divisions of the Har Dalam deposits, and the varying states of mineralization in which the remains occur, indicate that the divisions belong to two distinct epochs, and that a lengthy period of time intervened between them.

The reason of this must be sought for in the physical conditions under which the floor deposits of the cavern were laid down, and by which the gorge was deepened to its present level.

Probably no part of Europe has undergone such extensive changes in its configuration in recent times as the area now under consideration. The instability of the Mediterranean floor has been many times demonstrated during the present century, as for example the inundations along the Italian coast, the upheaval of the Adventure bank off Sicily, and the submarine volcanic outbursts off Pantaleria in 1892.

A few years ago there was a tendency among geologists to call in the aid of cataclysms and other sudden operations of nature to explain geological phenomena; but of late the pendulum of geological thought has swung to the opposite extreme, and the doctrine of cataclysms has made way for that of the uniformitarian, who advocates the theory of slow progression as the effect of uncountable centuries of imperceptible movement. The area around Malta and Sicily affords abundant examples of both kinds of operations. The Har Dalam gorge, like most of the valleys and ravines of Sicily, Malta, Gozo, and Tunis, is bounded by rugged and precipitous cliffs, whose sides offer abundant evidences of the action of marine and river agencies.

Many of these gorges were probably initiated during the upheaval which the area underwent in early Pliocene times, and afterwards served as the main lines of drainage of the country. Their bottoms are frequently covered with boulder beds and breccias, and their sides are scored with smooth curvilinear groovings suggestive of the action of considerable bodies of running water.

The Har Dalam gorge was then probably a tributary of the river whose bed may still be traced along the sea bottom for several miles to the south-east of Malta. On the banks of this river the late Professor Leith Adams discovered the remains of freshwater turtles, swans, and other aquatic birds, together with immense quantities of bones of elephants and hippopotami. This remarkable fauna existed at a time when the Maltese area formed a portion of the great Mediterranean land bridge, and when the climatic conditions of southern Europe were very different to those that now endure.

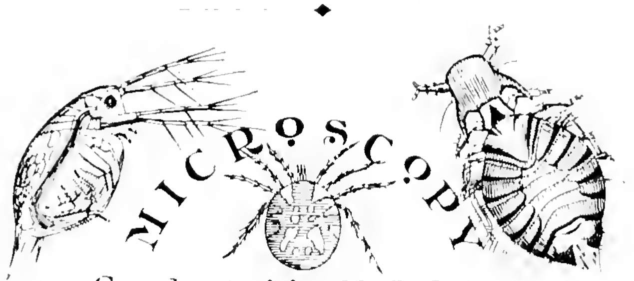
The present rainfall of the Maltese islands averages 17 inches, and it rarely exceeds 19 inches. The amount of water, therefore, that annually passes down the gorges to the sea has little or no erosive power, and is barely sufficient to remove the thin integument of soil which covers the bottoms in the higher reaches.

The question of the age of the Har Dalam cavern and its fossiliferous contents opens up an interesting field for investigation. The depth of the gorge is about seventy feet, and the cavern is situated at a height of forty feet from the bottom. The limited hydrographical area of the gorge renders it impossible, whatever the rainfall might be, to fill the gorge to a height sufficient to fill the cavern. The upper series of floor deposits were therefore laid down at a time when the gorge was very much shallower than it is now. It is hardly possible to express the antiquity of these layers in terms of written history, for the estimation of time by the rates at which rocks are denuded and built up is dependent upon so many variable factors that such chronometers are at best uncertain and unreliable. The Phœnician temples, tombs, and water tanks which are found in this gorge, at a level lower than that of the Har Dalam cavern, indicate how little the forces of erosion have effected since the time when they were constructed, about 3000 years ago.

Recent researches in the Nile delta have shown that two separate cultures existed prior to the advent of the Egyptian dynasties and Pyramid builders, thus giving a continuous history of 8000 years for man in Egypt. The ruder stages that characterize the Paleolithic and Neolithic periods in Europe are wanting around the Nile, but this is explained by the fact that the alluvial deposits of the Nile basin are not much more than 8000 years old. Observations have shown that during the last 8000 years the rate of deposition of Nile alluvium has averaged about one yard in a thousand years.

The Lorings indicate that the average maximum thickness of the Nile mud in the valleys is about eight yards, and this points to the conclusion that immediately prior to the time when the first layer of mud was formed, the rainfall was sufficient to fill the river valleys and prevent the deposition of the alluvium. The configuration and general physical features of the Egyptian Wieds and the Maltese gorges have much in common. The climatic conditions of the two areas are now, and probably always have been, similar. It is, therefore, probable that the work of gorge erosion was contemporary and that the depth and extent of the Har Dalam gorge differ but little from what they were at the time when the great change in the climate set in. If it were possible to fix the exact time when the upper series of beds in this cavern was deposited, then the age of the stone implements and other relics of human industry which they contained would be determinable. It is not probable that this will ever be done. To do so it would be necessary to revert to a period when the streams that coursed down the gorge were of sufficient magnitude and power to rasp away the greater portion of the forty feet of hard semi-crystalline limestone that once lay between the mouth of the cavern and the present bed of the gorge. The time occupied by the waters of the stream in the work of corrosion and erosion must be added, and this [illegible] already been pointed out is an indeterminable factor.

The evidences afforded by the Santon cave and the ossiferous loams of the Har Dalam cavern bring the solutions of the problem bearing on the migrations of pre-historic man in the central Mediterranean one step nearer. It is true the step is a short one, but the work of exploration proceeds apace, and the time will come when the gulf which at present separates the domain of the antiquarian from that of the geologist will be bridged by discoveries that will clear away the mist of uncertainty with which the subject is at present obscured.



Conducted by M. I. Cross.

Substage Condensers.—It is gratifying to observe the number of first class substage condensers that are offered by manufacturers, and it is a distinct indication of growing knowledge and appreciation of good things on the part of workers.

It was at one time an easy matter to make a choice when only two or three systems were available, but it is evidently presenting some complexity now, and in response to correspondents enquiries we propose to give a few hints on the subject.

The main features of a condenser are: (1) *The achromatism*, (2) *aplanatism*, (3) *magnifying power*, and (4) *the size of the field lens*.

Achromatism and *aplanatism* can be considered together, but the latter is the more important. Recognising this, there is a tendency on the part of makers to claim greater aplanatism than is actually yielded; this can, however, easily be verified by the methods described in the text-books. Achromatism is a desirable quality, but we doubt the advantage of an apochromatic over an achromatic condenser; we would as readily work with the latter as the former provided the aplanatism were as well corrected, and this is frequently the case. Expense may therefore be avoided without loss of efficiency in this respect. The solid illuminating cone that an objective will bear has been frequently discussed. It is generally stated that three-fourths the full aperture is the best, but it will be found that the majority of lenses will not bear more than two-thirds without deteriorating in performance; there are some exceptional ones that will take more than a three quarter cone, but this is not the rule, and a light filter is usually requisite.

The power.—The magnifying power of the condenser should not exceed half that of the objective, less rather than more than half is always preferable. Many systems are arranged to work satisfactorily with the front lens removed, and by this means high and low power effects are secured in one combination.

Size of field lens.—The reason for the popularity of the Abbe illuminator, with its glaring imperfections, is on account of its large field lens and the ease with which it can be worked. A high power condenser must of necessity have comparatively small lenses, and requires as great care in manipulating as the objective itself. The Abbe achromatic condenser was an attempt to maintain the easy working of the Abbe illuminator in a corrected form, but it is really too heavy and clumsy and restricts the movements of a mechanical stage. The best condensers have, as a rule, the largest field lenses that can be advantageously fitted, but this point is deserving of special consideration when making a decision.

Recommendations.—From the foregoing it will be possible, with given objectives and a maker's catalogue, to choose the most suitable condensers. If a man proposes to restrict himself to low and medium powers, not exceeding say ¼ in., he can readily make a choice, and we would like to specifically mention [illegible] introduced by Mr. C. Baker, of 244, High Holborn, [illegible] this a specially large field lens is provided, the power [illegible] is exactly the right one for histologists and workers with medium power objectives, while the aplanatic aperture closely approaches [illegible]. We have found it most effective in some work we have been doing recently, and great credit is due to the maker for its introduction.

The worker who does not go beyond an aperture of 1·25 can do all that his lens will permit with a dry condenser having the nominal aperture of 1 [illegible] and yielding an aplanatic cone of [illegible] as several of them do. If higher apertures are used, an oil immersion condenser is necessary. This advice has an appalling sound, but it is [illegible] recognised that such systems can usually be worked dry, and will then give an aplanatic cone exceeding [illegible]. Such is the case with Watson & Sons' holoscopic condenser. Again, the top lens can be removed and a condenser of low power secured. Oil immersion condensers are too little appreciated, and it will be found, if it is desired to work with medium and high powers, that the oil immersion system will serve every purpose and is practically a universal condenser.

The Quekett Microscopical Club.—The practical work done by this Society, which was founded in the year 1865, is recognised as being of the first importance.

The meetings are attended by the foremost microscopists of the day. The journal, which is published bi-annually, and gives reports of the papers read and the proceedings generally of the club, is always worthy of careful perusal, but the great characteristic feature of the club is the welcome it extends to the amateur microscopist and the means it affords for bringing the novice into touch with the sound principles of manipulation, working and collecting.

On the first Friday in each month a "Gossip" evening is held, at which specimens are exhibited by members and discussed conversationally, the regular business meetings of the society taking place on the third Friday in each month. There is, in addition, a first-rate library, and cabinet containing 6000 slides, which are at the disposal of the members.

We have before us a list of the excursions for the forthcoming season. These take place principally on Saturday afternoons, and have for their object the collecting of material that will afford interesting studies microscopically. "Pond life" has always been a very strong subject with the club.

Visitors are cordially invited to the meetings, which are held at 20, Hanover Square.

When it is stated that all these advantages are offered without entrance fee for the modest sum of 10s. per annum, it will be conceded that every microscopist ought to make a point of becoming a member, and so supporting, in a practical manner, a club which has in the past and will continue in the future to promote the best interests of every feature in microscopy.

Communications on the subject of membership should be addressed to the Hon. Secretary, G. C. Karop, Esq., M.R.C.S., 198, Holland Road, W., or to the Hon. Editor, D. J. Scourfield, Esq., [illegible], 63, Queen's Road, Leytonstone.

We hope, as the season advances, to give short reports of the excursions of the Quekett Club members, giving details of the material that is collected and the place where it is found.

Ringing Slides.—Many amateurs prepare and mount specimens remarkably well, but few manage to put the ring of cement on neatly. It requires practice certainly, but generally it is through using the cement in too thick a condition. Professional mounters have two bottles, one containing the cement, the other the solvent—generally turpentine or methylated spirits. The brush is first dipped in the solvent, then in the cement, and a thin coat is [illegible] on the slide as it is rotated on the turntable. Some [illegible] at once, others allow the first layer to dry and then complete the process; if there is sufficient time available the latter is the better way, but each time a fresh brushful of cement is taken it should be preceded by [illegible] in the solvent. The cement can then be deposited with cleanness and regularity.

Lecturers.—We have been applied to by a small Natural History Society [illegible] lecturer or demonstrator, who would give an evening [illegible] explanation of the principles and working of the microscope and its appurtenances. We should be glad to know of one who would like to make himself useful in this way and to put him in communication with our correspondent. A fee would be paid if necessary.

Notes and Queries.—*M. A. Holland.*—The "chalk" which you have been cleaning for Foraminifera is probably a manufactured article and consequently would be useless. Limestone from a cliff would be sure to yield the material you required. If you have not an opportunity of collecting this yourself, and will let me know, I shall be happy to send you a small quantity that would give you good results.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. Cross, Knowledge *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

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

Comet 1898 VII (Coddington).—This object, like the comets of Barnard (1892 V.) and Chase (1898 VIII.), was discovered by photography, and it remained visible for a considerable time. The observations, which number more than 400 in the aggregate, have been rigorously discussed by Mr. C. J. Merfield, of Sydney, and he gives definitive elements in *Ast. Nach.*, 3684-5. The comet passed its perihelion on 1898, September 14th, ·0442, and its orbit appears to deviate very slightly from that of a parabola.

The Discovery of Comets.—As far as is known there is at present nothing observable in the way of cometary objects. The small comet discovered by Giacobini in December last has now travelled beyond the range of our best telescopes, and the expected periodical comet of Brorsen has not yet been re-detected. But we shall probably not have long to wait for the discovery of new objects in this field, for March and April have been usually more productive than the winter months in furnishing them. No doubt many comets elude observation altogether, as the search for them is subject to many irregularities, and is very far from being exhaustive. The fact that a proportion of the known comets were found at times when they were long past perihelion, and were on the point of disappearance through increasing distance, warrants the inference that every year there are several small comets which visit our parts of space, and leave it without being sighted by those astronomers who make it their duty to search for these bodies. Some of the observers who have previously occupied themselves in this work have done exceedingly well, and established highly creditable records, but many additional hands are required to complete the thorough exploration of the sky month by month.

Fireball of November 27th, 1900.—This object was seen at 11h. 10m. by Prof. A. S. Herschel at Slough, Mr. H. Parsons at Leicester, and Mr. J. T. Cherryman at Plymouth. At the latter place the meteor appeared to be very brilliant and large, falling in a perpendicular direction from the Polar star. At Leicester the observer was startled by the passage of "a liquid mass of fire which illuminated the sky and fell slowly in a dignified sweep towards the south-west by south." Several fragments broke away from the central mass during its flight. The radiant point of the meteor appears to have been at about 47° + 45°, and its height 57 to 17 miles over the region of Ilfracombe. Its visible path extended over 40 miles, and its velocity was about 18 miles per second. Prof. Herschel has also investigated the real path of this interesting object, and places the radiant at 50° + 45½°. He finds the heights 50 to 15 miles, the length of path 35 miles, and velocity 16½ miles per second. The radiant between α and β Persei is that of a well-known shower of slow meteors at the close of November and beginning of December, and we are fortunate to have secured such a brilliant example of them.

Fireball of February 13th, 1901.—At 10h. 41m. Prof. Herschel at Slough observed a fine meteor, equal to Venus, traversing a short course in Aries from 30° + 17° to 25° + 12½°. It fell low in the west, and was intercepted by the house roofs which formed the sensible horizon. The meteor imparted a strong white glare to the sky for a distance of about 10° around it, and it moved with moderate speed. The same object was seen at Clifton passing down the sky to the right of the Pleiades from about 44° + 35° to 24° + 26°. It was very brilliant, but after a flight enduring two seconds it passed behind houses near the W. by N. horizon. The probable radiant of the meteor was at 72° + 41° near χ Aurigæ and this is really the focus of a well-known shower between about February 5th and 15th. Its height was from 56 to 26 miles and path about 30 miles over Pembrokeshire. These results are only approximate, and it would be useful to hear of other observations.

Fireball of February 27th, 1901.—Mr. Alex. Spark, of Aberdeen, reports an unusually brilliant meteor, at 8h. 45m., travelling in a N.W. direction. The colour of the head was bluish white, and it left a trail of reddish sparks. The fireball was also seen by an observer at New Deer, Aberdeen, at 8h. 53m., passing through Ursa Major, between the stars ϵ and ζ, and directed from between θ and 92 Leonis. It remained in sight 10 seconds. At Lerwick, in the Shetland Isles, Mr. A. Cruickshank noted the meteor at 8h. 51m., and describes it as [illegible] M [illegible] [illegible] Ursa Major [illegible] [illegible] showers [illegible]

Large meteors [illegible] February 18th [illegible] February 20 [illegible] but very few [illegible] American [illegible] fireball [illegible] Colorado and Wyoming [illegible] loud detonation.

THE APRIL LYRIDS.—[illegible] favourable [illegible] 1901 [illegible] April 18th so that observers [illegible] April 20th and 25th. This system rarely [illegible] conspicuous display, but it is very interesting from its connection with Comet I. 1861. The radiant of the shower is at 271° + 33°, between Hercules and Lyra, and the point probably shifts somewhat [illegible] eastward. Observations should be [illegible] to elucidate this feature. The immediate region of the radiant should be watched [illegible] on several nights before and after the maximum on April 20th [illegible] and the exact place of radiation should be [illegible].

THE FACE OF THE SKY FOR APRIL.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 5.38 A.M., and sets at 6.30 P.M.; on the 30th he rises at 4.37 A.M., and sets at 7.17 P.M. Sunspots are not likely to be either large or numerous.

THE MOON.—The moon will be full on the 4th at 1.20 A.M.; will enter last quarter on the 12th at 3.57 A.M.; will be new on the 18th at 9.37 P.M.; and will enter first quarter on the 25th at 1.15 P.M. The following are among the occultations which occur during the month:—

Date.	Name.	Magnitude.	Disappear-ance.	Angle from North.	Angle from Vertex.	Reappear-ance.	Angle from North.	Angle from Vertex.	Moon's Age.
Apr. 3	B.A.C. 4531	[illegible]	[illegible] P.M.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 8	[illegible] Scorpii	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 22	[illegible] Orionis	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
" 27	[illegible] Sextantis	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

On May 3rd there will be a penumbral eclipse of the moon, from 4.6 P.M. to 8.55 P.M. As the moon does not rise until 7.28 P.M., the eclipse is only partly visible at Greenwich.

THE PLANETS.—Mercury is at greatest westerly elongation of 27° 48′ on the 4th, and is a morning star throughout the month. He is not well placed for observation in our latitudes.

Venus is nominally a morning star, but is too near the sun for observation. She will be in superior conjunction at the end of the month.

Mars remains in Leo and may be observed throughout most of the night, setting on the 30th at 2.45 A.M. At the middle of the month he crosses the meridian at 8.15 P.M., and the illuminated part of the disc is 0.924. The apparent diameter diminishes from 11″.4 to 9″.0 during the month.

Jupiter is a morning star, in Sagittarius, rising on the 1st at 2.19 A.M., and on the 30th at 12.29 A.M. He is in quadrature with the sun on the morning of the 2nd and stationary on the 30th.

Saturn is also in Sagittarius, a little to the east of Jupiter. He rises on the 1st at 2.32 A.M., and on the 30th at 12.40 A.M. He is in quadrature with the sun on the 6th, and stationary on the 26th.

Uranus is in the most southerly part of Ophiuchus, [illegible] [illegible] the month. The planet [illegible] and on the 30th at [illegible].

Neptune [illegible] Taurus, setting on [illegible] soon after 11 P.M. [illegible] short [illegible] and 1.32 [illegible].

THE STARS.—About 9 P.M. on the [illegible] Leo will be on the meridian, Gemini [illegible] Orion in the west, Virgo in the south-east, Hercules in the north-east, and Ursa Major almost overhead.

Minima of Algol will occur on the 2nd at 8.23 P.M., and on the 22nd at 10.6 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 March Problems.

(C. D. Locock.)

No. 1.

1. Q to B1, and mates next move.

No. 2.

1. R (B3) to Bsq.

No. 3.

1. B×QP.

This has been rather ambiguously described as "a taking key." The P at B6 was left on the board by mistake. In a former version of the problem it was necessary to prevent a solution by 1. K to Q7ch, and 2. Q to B6.

C. L. Massy.—I can find no trace of any statement in KNOWLEDGE to the effect that problems known to have more than one key would not be printed. While agreeing with you that the search for a second key is generally profitless, and sometimes vexatious, I may, perhaps, point out that such search often discloses the hidden art of the composer in avoiding "cooks," which might otherwise have escaped the solver's notice. But the principal reason for allowing an extra point for a second solution lies in the fact that, without some such device for differentiating skilful solvers, the prizes and credit would probably have to be divided among some twenty or thirty solvers at the end of the year, a result which would hardly be regarded as satisfactory. As it is, competitors are at least spared the necessity of looking for a third or fourth key after a second has been found, an obviously time-wasting condition which holds good in most solution tournaments.

J. Baddeley.—I have written to enquire into the cause.

W. Jay.—No. 2, as you point out, would be impossible in actual play. The dual you mention in No. 3 seemed unavoidable.

B. Hosley.—The Pawn at B2 in No. 3 prevents a dual which would exist if the Black P, which it blocks, were allowed to move.

N. L. Gillespie.—No. 1 [illegible] 1. K to Kt4, P to Kt4 or K moves. No. 2 [illegible] 1. P [illegible] B×Pch.

J. W. Ty[illegible].—No. 1 [illegible] 1. [illegible] B to B7, B to B[illegible]. No. 2 [illegible] [illegible] answer [illegible].

H. S. Brandreth.—No 1. If 1. P to Q3, B × P. No. 2. If Q to R4, P × P dis. ch.

W. F. P. and *J. A. Nicholson.*—See answer to H. S. Brandreth.

C. F. P.—"The Two-move Chess Problem," by B. G. Laws, would probably suit you.

C. S. Hudson.—No. 2. If 1. B to Q3, KtP moves.

F. V. Wilhelmy.—Your solutions last month (correct) were received on the 15th, after this page had gone to the printers.

J. W. Meyers and *Alpha.*—Several competitors, like yourself, are still solving without any idea of "competing."

H. W. Elmore.—The fallacy of course is obvious enough, the only difficulty consisting in calculating the area of the "gap." I do not follow your argument which gives an area of 81 for the rectangle.

F. T. Mott.—Too late to reply to last month. P to Q3ch was incorrect.

SOLUTION TOURNEY.

The following are the leading scores up to date:—

Seventeen points.—S. G. Luckcock, J. T. Blakemore, G. W. C. Johnston, A. C. Challenger, A. Dod, W. Jay, S. W. Billings.

Sixteen points.—J. Baddeley, H. le Jeune, B. Harley, G. Groom, F. J. Lea, W. de P. Crousaz, W. H. S. M., N. K. Dutt, Endirby, F. Dennis, C. C. Massey, Eugene Henry, A. J. Head, J. Sowden, G. W. Middleton, E. Hunt, Vivien H. Macmeikan, A. E. Whitehouse, J. E. Broadbent, C. Child.

Fourteen points.—G. A. Forde (Capt.), A. H. Machell Cox, Alpha, H. Boyes, C. F. P.

Thirteen points.—J. M. K., W. Nash, C. C. Pennington.

Problem No. 3 was correctly solved in all cases. No. 1, on the other hand, claimed five victims, and No. 2 nine.

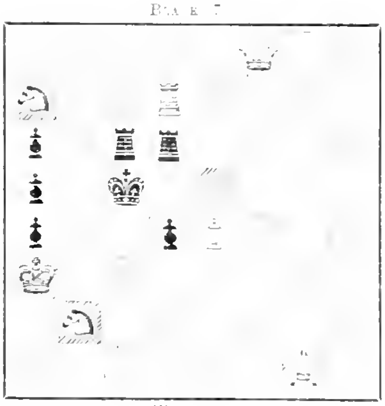
In reference to the Chess Puzzle given in the last number, E. J. P. points out that whereas the gradient from C to A is obviously two in five, or 16 in 40, that from B to C is only three in eight, or 15 in 40; which clearly shows that A C and C B are not in the same straight line. The same of course applies to B F and F A.

PROBLEMS.

By P. G. L. F.

No. 1.

BLACK (7).

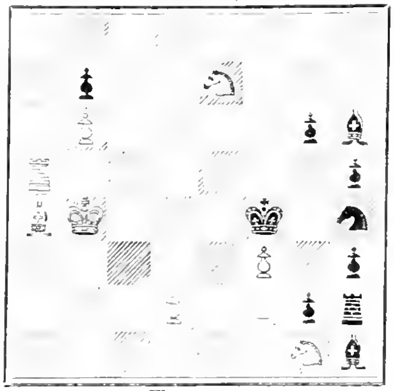


WHITE (7).

White mates in two moves.

No. 2.

BLACK (10).



WHITE (9).

White mates in three moves.

CHESS INTELLIGENCE.

The prize-winners in the recent International Tournament came out in the following order:—1, D. Janowski 10½; 2, C. Schlechter, 9½; 3, Von Scheve, 9½; 4, M. Tchigorin, 9; 5, S. Alapin, 8½; 6, J. Mieses, 7. M. Janowski's victory shows that he has completely recovered the form which he had evidently lost at the Munich Tournament last summer, when he could do no better than tie for the seventh and eighth prizes. Herr Schlechter on that occasion tied for the first three prizes with Mr. Pillsbury and Herr Maroczy. In the present tournament he has done equally well, and by his consistent form has proved his claim to be considered one of the first five players of the day. Herr von Scheve, who has been an absentee from tournaments for the past ten years, did far better than he has ever done before. Of the other veterans neither Herr Winawer nor the English representatives did very well, though Mr. Blackburne came out next to the prize-winners, and Mr. Gunsberg at one time seemed certain to secure a place. Mr. Marshall has not sustained his reputation, already considerably dimmed by his recent performances in America. Signor Reggio, the winner of the recent Italian National Tournament, made a very promising first appearance, and is evidently considerably stronger than Vergani, the Italian representative at Hastings in 1895.

A Russian National Tournament held at Moscow had previously resulted in the victory of M. Tchigorin, E. Schiffers being second, and D. Janowski third. The latter evidently derived some benefit from the practice obtained on that occasion.

KNOWLEDGE
AN
ILLUSTRATED MAGAZINE
OF
SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

VOL. XXIV.] *LONDON: MAY, 1901.* No. 187.

CONTENTS.

THE SIZE OF OCEAN WAVES.—III.

By VAUGHAN CORNISH, M.SC.(VICT.), F.C.S., F.R.G.S.,
Associate of the Owens College.

IN a previous article I gave the results of Admiral Coupvent des Bois' attempt to connect the average height of the waves with the strength of the wind. The Table VI. embodying this result was the outcome of about 7000 observations made on board the *Astrolabe*. More recently Captain D. Wilson-Barker, H.M.S. *Worcester*, has published* a table showing the connection between wind and wave according to his own experience. This extends over many years at sea, during which he was many times round the world in sailing ships in high southern latitudes, and made many measurements of waves combined with simultaneous observations on the strength of the wind.

TABLE VII.

Wind velocity and corresponding sea disturbance (D. Wilson-Barker).

Beaufort Scale.	Description of Wind.	Velocity in Miles per Hour.	Sea Disturbance.	Height of Waves in Feet.	Description of Sea.
0	Calm ...	0	0	0	Calm
1	Light airs	3	1	0–1	Very smooth
2	Light breeze	9	2	1–2	Smooth
3	Moderate breeze	16	3	2–3	Slight
4	Fresh breeze ...	24	4	3–5	Moderate
5	Strong breeze	34	5	6–10	Rather rough
6	Gale	42	6	10–18	Rough
7	Strong gale	55	7	18–28	High
8	Hurricane	70	8	28	Tremendous

The tables of Paris, Coupvent des Bois, and Wilson-Barker are not perfectly comparable throughout, but I think we may venture to arrange in parallel columns the four greatest values for average height of waves, and to assume provisionally that they represent three independent sets of observations of average height of waves in deep water and open sea, during strong breeze, gale, strong gale, and a gale of hurricane force.

TABLE VIII.

Height of Waves in feet.

	C. des Bois.	Paris.	Wilson-Barker.
Hurricane	28·54	25·43	28
Strong gale	20·67	16·57	23
Gale	15·42	—	14
Strong breeze	10·83		8

With regard to the *length* of waves, I think most observers will agree that the greatest average length of wave is not observed where the wind is blowing strongly but where the sea is heaving with a steady swell in a comparatively calm atmosphere. Thus in Lient. Paris' record the maximum average wave length for a single day (771 feet) occurs when the state of the sea is described as *grosse houle*, a heavy swell, whereas the greatest average length for a day of storm (très-grosse mer) was 590½ feet. As the average force of the wind for "très-grosse mer" was indicated by the number 9, and that for "grosse houle" by the number 5 (on a scale of 0-11), the above appears to be the necessary interpretation of Paris' figures. In this matter, however, we are fortunately able to adduce other evidence besides the observations made from ships at sea. Observations of the intervals of time between the breaking of the waves on shore are easily made, the intervals of time are greater for the larger waves, and the longer intervals are those recorded during "ground-swells" in calm or comparatively calm weather. Thus on December 29th, 1898, in the fine weather with north-westerly breeze following a great storm accompanying an atmospheric depression which had travelled quite across the Atlantic, I observed at Branksome Chine, near Bournemouth, an uninterrupted series of 139

* *Quarterly Journal of the Royal Meteorological Society*, Vol. XXV., No. 109, January, 1899, p. 15.

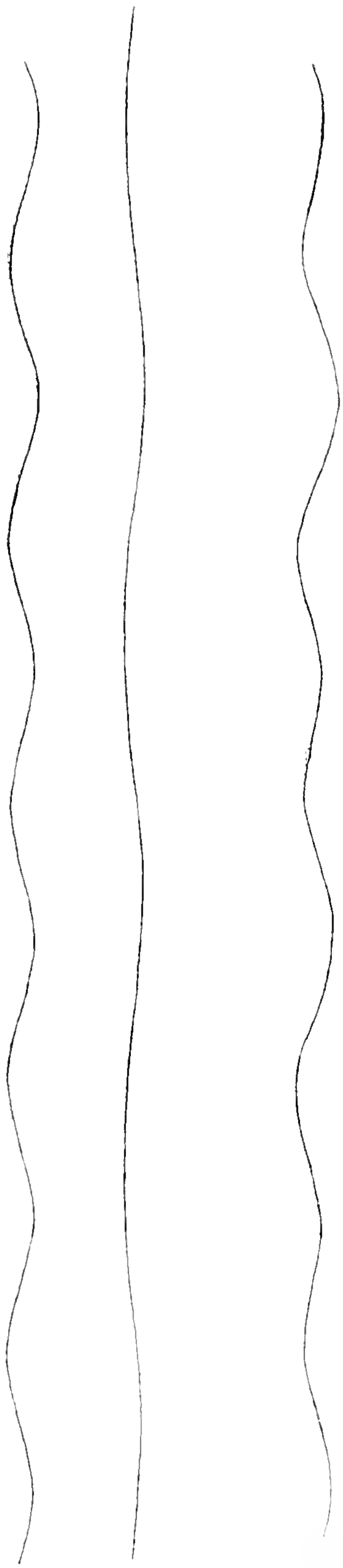


FIG. 1.—Combination of Wave, 600 feet long and 30 feet high, with swell 1150 feet long and 20 feet high.

Scale:—Horizontal, 1 in. = 400 ft., Vertical, 1 in. = 200 ft.

breakers. The average interval between succeeding breakers was 19.35 seconds, from which it follows that the average wave length in deep water must have been 1918 feet. This is calculated from the formula

Length of wave in deep water in feet = square of the period in seconds × 5·123.

This formula is derived theoretically from the known behaviour of liquids under the action of gravity, and has been verified to some extent by observation. Its substantial accuracy when applied to a swell of no great steepness travelling in a fairly calm atmosphere is, I believe, beyond question. The corresponding velocity of the wave is 68.7 statute miles per hour in deep water, which is slightly less than the velocity assigned by Capt. Wilson-Barker to a storm of hurricane force. Sir George Gabriel Stokes has observed breakers with a uniform period of 17 seconds; and I find that a period of 15 seconds is not uncommon with westerly swells on the south coast of England. A 15 second period corresponds to a wave length in deep water of 1153 feet. Thus the average interval between the wave crests observed during a storm at sea seldom exceeds 600 feet, although the period of breakers frequently indicates a wave length twice as great.

I do not know whether attention has been drawn to this anomaly, and I have not met with any published facts which explain it. I propose the following explanation.—The swell frequently arrives before the storm; subsequently when the wind gets up the sea becomes covered with short steep waves; these grow in length, and gradually the swell becomes less conspicuous, until at last it is nearly or quite invisible in presence of the storm waves (say between 300 and 600 feet in wave length). The natural inference would be that the amplitude of the swell must be small as compared with that of the storm wave. This, however, is not necessarily the case, as an examination of the diagram will show. In looking at this it must be remembered that when waves are observed at sea we have not a fixed platform to observe from, nor can their profile be traced against any fixed structure. The ship rises and falls with the long swell, and the observer has very little notion where the line of mean sea level is; and for this reason I have not drawn any datum line in the diagram. What he does notice is whether the water surface at any place is convex or concave, and, more particularly he notices the advance of the convexities of crests.† Now it is obvious that even though the long swell have an amplitude equal to that of the shorter storm wave yet its curvature is less, and therefore it is less potent than the latter in determining the positions of crests, *i.e.*, marked convexities of surface.

To assume that during storms there is a long swell (say not less than 1100 feet) of an amplitude equal to that of the storm wave would, however, be going somewhat beyond what the facts seem to warrant, but that such invisible swells may have a considerable amplitude seems to me quite possible from what we know of the swell remaining after a storm, of the distances which these swells traverse, and of the size of the breakers which they yield, and finally of the variation of the amplitude of successive waves in a storm. Fig. 1 shows a portion of the actual wave surface due to the simultaneous existence of two undulations with length 600 feet, amplitude 30 feet, and length 1150 feet, amplitude 20 feet. Commencing on the left with the two undulations at the same phase, at mean sea level, and subsiding, there are shown in the figure five

† The curvature at the crest being sharper than in the troughs, a difference which, however, I have not shown in the diagram.

crests of the 600 feet undulation and three crests of the 1150 feet undulation. The resulting wave surface of the sea in this case would at any one moment show a series of ridges and hollows differing from one another in wave length and amplitude. This series would be followed by other series, identical with it. The third (lowest) line of the diagram is a portion of a series. It contains five wave crests, *i.e.*, the same number as the shorter constituent wave contains. Measuring from the diagram I find that, reckoning from the left, the succeeding waves have—

Amplitude 28·85 feet. Length 575 feet. Length 625 feet.
Amplitude 27·5 feet. Amplitude 30 feet.
Length 575 feet. Length 625 feet.
Amplitude 27·5 feet. Amplitude 35 feet.

The average wave length is 600 feet, precisely that of the shorter constituent, the average amplitude is 29.77 feet, which is (within the errors of measurement) identical with the amplitude of the same wave. The record of measurement of waves in such a sea as usually published, that is to say, giving the average dimensions of a series of waves, would give no indication of the existence of the long swell. It would perhaps be just visible if the light were good as something running faster than the waves, not unlike the shadow of a passing cloud upon the water, but I think its magnitude would be much under-estimated. This swell does not greatly affect the amount of surface disturbance, though it renders it more irregular; but at a depth where the effect of the 600 foot wave is no longer felt the heave of the 1150 foot swell is still strong. Thus, although the existence of the long swell may be barely discernible by the eye in a storm, and although the recorded (average) wave measurement may not reveal its presence, yet the sea is really in a very different state when such a swell is running from what it would be if affected only by the recorded wave of 600 foot length and 30 foot amplitude. In drawing figures in which the amplitude of the swell is made equal to that of the storm wave I do not intend to assert that this is the usual condition; the intention is rather to show how even a great swell is masked by the shorter wave.

I am trying in these articles to tell what is known about the size of ocean waves, and how that knowledge has been obtained. I have now reached the point, to which one comes sooner or later in almost every enquiry, when it is advisable to look more closely into the meaning of the word which designates the thing investigated. For research in natural phenomena I prefer this plan to that of beginning with a definition. We find the surface of the sea covered with a series of ridges and furrows which are not uniform on the one hand, but have on the other hand only a moderate range of size. There are of course wavelets also present, but these are easily distinguished from the greater waves which we want to measure. The difference in size between succeeding ridges seems to be mainly due to the existence of two or more sets of undulations each of which may be regular. An illustration of this may be obtained by watching one wave crest as it advances. The changes of form which it undergoes are readily understood on the supposition that one billow is catching up and passing another. These changes are the same as those shown in the figures in passing from crest to crest of the combined wave. Now if we want to know the size of ocean waves it is evident that we must make up our minds whether we mean the size of the ridges and furrows which re[illegible] the tim[illegible] actually [illegible] surface of the ocean or, on the other hand t[illegible] constituent undulations the superposition of [illegible] those ridges and furrows.

The actual ridge or mound of [illegible] not only the chief visible phenomenon but it [illegible] often a terrible reality, which the sailor ca[illegible] On the other hand the constituent undulations are what chiefly receive the attention of the theoretical man, and they have in some respects a greater individuality than the "seas," for they retain each their length and speed, and, sorting themselves as they travel beyond the storm area, they partition out the ocean among them the longest and swiftest coming to the front, the slower and shorter lagging behind.

In the systematic records of the size of ocean waves, writers have generally attempted to follow the procedure of the theoretical man in this matter. Thus Monsieur Bertin, in his excellent *Memoir on the Experimental Study of Waves*,‡ says, "We are certain in adopting 16 mètres (52½ feet) as the maximum limit of height to have got beyond all the observed values. I must further remark that I only speak of waves in the open sea, and of those belonging to a single swell. An isolated rock 25 or 30 mètres (82 to 98 feet) high may be covered by a breaking sea. Waves belonging to different systems of swell may ride one over the other, giving rise to topping seas without speed, and with a short period, or to any other irregular and exceptional agitation. . . . ."

In December, 1900, I crossed from Liverpool to Boston in ss. *Ivernia*, and heavy weather was met with. Quoting from the report sent in to the U. S. Hydrographic Office, we had on December 6th strong westerly winds with high sea; December 7th, strong squally wind, increasing to strong gale, with heavy regular sea; December 8th, strong gale, S.W. W., N.W.; December 9th, N.W. wind, moderate to force 6, and backing W.S.W., increasing to force 8; December 10th, fresh gale, with frequent squalls, wind hauling to N.N.E. and N.E., short high sea; December 11th, wind west, having hauled S. to S.S.W., increasing with hard snow squalls and falling thermometer, short high sea; December 12th, moderate gale to moderate breeze at midnight; December 13th, wind force 6-7, with occasional snow squalls, sea rough.

I paid particular attention to the question of the height of the waves, and tried to consider the matter without bias. It seemed to me quite as important to know the height of the larger seas occurring from time to time as the average height of the waves. Thus the average height of the waves on December 8th was less than the elevation of the lower deck, but the lower deck on the weather side was unsafe on account of the occasional big "seas," of which I measured one or two of 40 feet or upwards. It is these larger seas which rivet the attention, and remain in the recollection of a spectator. I do not think anyone could fairly be blamed for saying that on this occasion the ship met with waves about 40 feet high, for they were not seen only once but many times, yet, as well as I could guess, the *average* height of the waves was not more than 20·25 feet. I think it probable that when we hear from seamen that they have known the waves in a storm 40 feet, or it may be 50 or 60 feet in height, we must interpret

‡ Institution of Naval Architects, April 1873.

the statement to mean that this is the measure, or estimate, of the average height of the greater waves of which some were encountered and a number seen during the storm, and I see no reason to quarrel with such a mode of statement. It admits, however, of an apparent discrepancy of probably 100 per cent. between the values assigned to the height of ocean waves according to whether we adopt the concrete or the abstract notion of a wave.

GIANT OSTRACODA: OLD AND NEW.

By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., etc.

As students are aware the species of Entomostraca are for the most part very inconspicuously conspicuous, and among those of them which are thus notable not for being very large but for being very little the Ostracoda, if not absolutely foremost, are certainly well to the front. Recent researches, however, have shown that in this group as in others an astonishing disparity of size may separate exceptional members of it not only from the minutest forms but from the average dimensions.

In 1880, Dr. G. S. Brady in the first volume of the "Challenger" Zoological Reports described a new genus and species from the South Pacific under the name *Crossophorus imperator*. After giving the length as "⅓ of an inch (8.4 mm.)," he refers to it with a kind of enthusiasm as "this noble species, certainly the largest of the known Cypridinidæ." The family in question was already itself distinguished among the Ostracoda by having representatives which could boast of some such exorbitant length as the sixth of an inch. By abruptly doubling this the *Crossophorus* would probably attain a bulk about eight times that of its largest known competitor. In 1896 Drs. Brady and Norman described another specimen, assigned to the same species, with a length of 7 mm. Though both specimens were reported from very great depths of nearly equal temperature, it is remarkable that the first, a male, was taken a little to the east of New Zealand, the second, a female, "was procured by the 'Porcupine' Expedition of 1869, in the Atlantic, west of Donegal Bay, Ireland." The same length of 7 mm. is reached by *Cyclasterope hendersoni*, Brady, 1897, which Mr. Henderson, of the Christian College, Madras, brought to light by dredging in Madras Harbour.

At the close of last year a new species, *Asterope arthuri*, 8 mm. long, was described among the crustacea brought by Dr. Arthur Willey from the South Seas. In regard to this interesting form it may be mentioned that before the specific name had been given, some of its appendages were figured in the volume of KNOWLEDGE for 1899 in the course of an essay dealing with the general structure of the Ostracoda (Vol. XXII., p. 31).

In 1898 Professor Sars described a new genus and species under the title "*Megalocypris princeps*, a gigantic fresh-water Ostracod from South Africa." This species, from a pond near Cape Town, attains a length of 7.30 mm., while apparently not full grown, and, as it belongs to the family Cyprididæ, in which the forms are usually very small, its "truly gigantic size" is even more surprising than that noted in the preceding instances. In 1900 M. Jules Richard reports a "*Giganto-cypris*," about 10 mm. in diameter, as having been dredged by the Prince of Monaco from a great depth off the Azores.

These examples, however, do not exhaust the possibilities of the Ostracode group, for Dr. Gilchrist in December, 1899, while conducting marine investigations on board the South African Government vessel the "Peter Faure," and dredging in 90-100 fathoms off Cape St. Blaize, obtained specimens of Ostracoda which much surpass the dimensions above quoted. The specimens were speedily forwarded to me by Dr. Gilchrist, and were examined at once. That they have not been sooner recorded is due in part to the well-founded and growing dislike of preliminary notices, and in part to my apprehension that there had been made elsewhere an earlier discovery of a magnificent Ostracode, which might prove to be the same species. After talking the matter over with a scientific friend, I am now induced to think with him that the case is one of exceptional interest, in regard to which publication should no longer be delayed. The fact is that the specimens have a length of 15.5 mm. by a height of 12.5 mm., so that the noble *Crossophorus imperator* and the truly gigantic *Megalocypris princeps* are positively dwarfed by the comparison.

The new species, for which I propose the name *Crossophorus africanus*, has its generic position pretty well assured, since, among other points, to quote Brady and Norman, "the peculiar arrangement of the armature of the caudal laminæ is unlike that of any other known genus." But the new species, though agreeing in the general plan of arrangement, differs in detail, having only five principal spines instead of the seven which the smaller species displays. The mandibles have the bifid masticatory appendage, found in one or two other genera, but not there densely setulose as it is here. The maxillipeds have the large sub-triangular lamina, fringed with plumose setæ, and ending with a small lobe also fringed. This lobe is peculiar to *Crossophorus*, but it is much less clearly developed in the Irish specimen of *C. imperator* than in the New Zealand specimen. From the Irish *C. imperator* the new African species is strikingly distinguished by the apical part of the vermiform limb.* Here it forms a regular mouth, one jaw ending in a tooth, which confronts in the other a neat circlet of denticles. In the Irish specimen the tooth confronts "several (six?) finger-like curved processes which are ciliated on the edges." In the New Zealand specimen the limb is described as being "almost exactly like that of *Cypridina*." The result of these comparisons is to make me believe that we have to do with three specimens of the genus, first, the original *Crossophorus imperator*, Brady, from the Pacific; secondly, the species described by Brady and Norman, of nearly the same size, from the North Atlantic, which may be distinguished as *Crossophorus imperialis*; and thirdly, the new African species, *Crossophorus africanus*. For the latter detailed drawings have been already prepared, and these with accompanying description will, I hope, in due time more fully explain, and adequately justify this preliminary decision.

That an isopod which I find parasitic within the new species is itself likewise new may be affirmed without hesitation. The name I propose for this is *Cyproniscus crossophori*. It bears a strong resemblance to the much smaller *Cyproniscus cypridinæ*, Sars. Its distinctness will be apparent in the account and figures which are reserved for their appropriate place in the "Marine Investigations of South Africa," published by the Cape Government.

* For the general appearance of this strange appendage, see the figures in KNOWLEDGE, Vol. XXII., pp. 30, 31.

THE STRONGHOLD OF THE NUTHATCH.

A STORY OF SIEGE AND DEFENCE.

By A. H. Machell Cox, M.A.

Picture a sleepy old rectory garden—a very paradise of birds—merging into a little rambling spinney, and lying so close beneath its shelter that the gradual, almost imperceptible transition only serves to enhance the sweet smell of the woodland. Here and there a fine old oak breaks the stiffness of surrounding evergreens. One such tree is so persistently visited all the year round by a pair of nuthatches as to arouse in the practised birds-nester a suspicion which a closer scrutiny proves to be well founded. At a height of rather more than thirty feet from the ground is a hole, clearly enough the socket of a branch long since defunct, and only arresting attention by its unnaturally smooth and rounded appearance. For such an eligible building site as this there must have been at one time applicants in plenty among the various birds that seek a habitation in ready-made cavities, but in the end our nuthatches evidently obtained the premises on a long lease, and for many a year (with one notable exception, to which I shall presently refer) their tenancy has remained undisputed. Nor is the reason far to seek. Against birds no larger than itself, the sturdily built nuthatch, with its strong formidable bill, is perfectly capable of holding its own, while against more determined aggressors like starlings it adopts the ingenious precaution of plastering up the entrance to its home with mud, and reducing it to such a size as will exactly meet its own requirements. This is a well-known peculiarity; that it forms an invariable feature of the household arrangement cannot indeed be positively asserted, but from all accounts the exceptions to the rule must be very few indeed. Similarly it is recorded that before a nuthatch can be induced to take possession of a nesting box in a garden, its habitual cuteness leads it to detect the lid opening on a hinge, so fatal to privacy, a drawback which it will at once proceed to remedy by a plentiful application of clay. So skilfully is the work done in the first instance, that when the nesting season comes round again, only slight repairs and alterations are required; but these receive the most scrupulous attention, and even in the depth of winter an occasional inspection is made, and these all important defences overhauled. I do not recollect ever having seen the male nuthatch assist his mate in any of the actual work, but he is invariably somewhere at hand in close attendance, and ever ready in the spring to serenade her with his cheery long-drawn whistle; in the winter he is perhaps apt to be self-assertive, but during the time of courtship I have watched him offering, with an air of the greatest gallantry, choice morsels of food to his mistress.

Immunity from danger had, as I have said, been long enjoyed by this particular pair, and it was with some compunction that I yielded at last to my instincts as a birds-nester, and resolved to exact the toll that seemed so ready to my hand. Had I indeed anticipated that any disastrous consequences might attend my raid I should certainly have abandoned the idea; but I argued from what I knew of their general disposition that there would be little likelihood of their home being deserted for any cause short of deliberate eviction. Accordingly at the time when I calculated that the eggs should have been laid, I secured a ladder (without the aid of which the hole was inaccessible), and armed with chisel and hammer ascended to commit the burglary. My intention was to enlarge the entrance sufficiently to enable me to insert a hand and investigate the interior, but I soon found that I had underrated the difficulty of such a task. The wood was extraordinarily hard, and the mud defences themselves could hardly have been removed without tools; moreover the distracted owners, taking up positions within a few yards of me, never ceased to protest loudly and vigorously, and altogether showed such keen distress that I was more than once half inclined to desist. When, after two hours' hard work, the nest was brought within reach and proved to be empty, it almost seemed like a judgment on persecution. It only remained for me to do all in my power to repair the damage done, and some wet clay soon enabled me to reduce the hole to its original dimensions. Hardly had I descended to the ground when a blue tit appeared on the scene, and, perching for a moment on a rung of the ladder poked his head into the hole with characteristic curiosity. A few moments later, to my great satisfaction, I witnessed the return of the rightful occupants, who without further ado proceeded to complete my amateur work as a plasterer. So ended the first act of the drama; reference to my notebook shows that the date was April 17th.

For just a week the nest was left undisturbed, and then I made a second investigation. During the respite the rude clay had by some mysterious process, the secret of which the nuthatch seems to share with swallows and house martins, been hardened to the consistency of cement, the whole surface having been so scored all over by countless indentations of their beaks that it presented the appearance of elaborate stucco work. This time it was only the work of a minute to make a breach, and the results though not altogether successful, were on the whole satisfactory. A single egg was discovered in the nest; this I carefully replaced and a fresh supply of clay was utilized for the needful repairs. Once more the birds returned undaunted.

Now a fresh complication arose which quite altered the aspect of affairs. The next morning I was approaching the tree quietly to see how things were going on, when I caught sight of a bird, which proved to be a starling, busily pecking away at the entrance to the hole. The fact was that all the starlings in the neighbourhood were just then turning their thoughts to the business of nesting, and the sharp eyes of one pair had already discovered that this hitherto impregnable position had been tampered with, and that the clay while still damp and soft presented no insuperable barrier. Possibly they had witnessed the whole proceedings of the previous day and laid their plans accordingly. However that might be, I determined to defeat their object. Fetching my gun I cautiously stationed myself in hiding among the bushes beneath. I had not long to wait. A starling settled noisily on the top branch and was at once joined by another. There they commanded the situation and their purpose was unmistakable; as I wished, however, to catch them *in flagrante delicto* I still awaited developments. Presently first one and then the other nuthatch returned for a moment to the tree, but scenting danger flew off again uneasily. An interval ensued during which the conspirators (myself included) remained motionless at their several posts, and then the female came back with a large bit of clay in her beak, and after flying round the tree once or twice alighted on the trunk on the side sheltered from the view of the starlings. Gliding quickly down she suddenly slipped round to the hole, and was beginning hastily to attend to repairs, when one of the starlings with a harsh chattering noise swooped viciously down upon her. In less time than it takes to write the other nuthatch had come to the rescue, only to find the attack reinforced by the second starling. Taken at a disadvantage the nuthatches had to beat a retreat, and the original starling—the principal aggressor—stood screaming triumphantly at the mouth of the hole. At that instant I fired, and it dropped dead; on examination I was interested to find that it was a female. Once more the nuthatches gave a striking example of their intrepidity, for the report of the shot had hardly died away when they were both back at the tree resuming operations with as much apparent unconcern as if nothing at all had happened. I mounted guard a little longer and presently shot another starling on the tree, and by way of enforcing the lesson hung its body up within a few feet of the hole. Knowing, however, the pertinacity of these birds, I did not feel too sanguine even then that the mischief would go no further.

On the following day, when I went into the garden before breakfast, the first thing that met my eye was a nuthatch on the path in front of me where it was busily picking up mud. This it did by carefully detaching and rolling together a pellet about the size of a shilling, with which it flew off straight to the hole. A single glance at the latter more than confirmed my misgivings. The starlings had not only removed every trace of the protecting clay but had actually ejected the egg from the nest; the broken shell lay on the ground beneath. Undeterred by the grim scarecrow before them a number of these marauders had gathered on the scene and were apparently actively disputing the possession of so desirable a building site. Desperate but determined as ever, the nuthatches used most strenuous efforts to get the gaping hole plastered up afresh. But against such odds their present task was about as profitable as pouring water into a sieve, and it was only too obvious what the end must be. At this critical moment I hit on a plan by which I was able to befriend them to some purpose and make amends for the injury they had previously suffered at my hands. It was simple but effective. With the aid of a hammer and nails, I fastened a bit of wood securely over the hole in such a way as to leave it just large enough for the nuthatches; this was a rather unsightly makeshift, but a further application of clay served both to conceal the deficiencies in this respect and to restore the original character of the threshold. While this work was going forward, both nuthatches stood on the tree close beside me, and no longer uttered the notes of alarm which had been so incessant before. They lost no time in testing the result when I descended the ladder, and it was a comical sight to see the female's frantic contortions in squeezing through the hole which was now inconveniently small. This, however, was clearly a fault on the right side, and the nuthatches were after all left in possession of the field. The starlings were sensible enough to acknowledge defeat, but before doing so one individual (possibly the survivor of the original pair) planted himself at the mouth of the hole, and, thrusting in his head as far as possible, railed at the dauntless little inmate in unmistakable Billingsgate. Then he like the others decided to raise the siege, and peace reigned once more.

A whole fortnight passed, and the nuthatches toiled indefatigably to make good their own defences behind the improvised shelter which they evidently considered insufficient; certainly their previous experience might well justify misgivings as to my present *bona fides* in affording them protection. Eventually the traces of their labours could be seen extending inwards to a depth of more than six inches. During this period I observed that they generally repaired to one particular spot on the path in order to fetch their supply of mud, coming and going with such singular directness that, when one day I had inadvertently placed myself where I interrupted the traffic, I was startled to see the busy little worker pass and repass within a foot of my head with an absolute disregard of my presence. A well-known writer has indeed suggested from close observation of a tame nuthatch that these birds are peculiarly short sighted, and while the action I have mentioned does not necessarily support such a theory (which indeed it is hard to accept without further evidence) it has a certain interest as bearing on the question.

It is satisfactory to be able to record that this pair of plucky birds eventually brought off their brood triumphantly after all their persecution, and appear likely to enjoy for a long time to come the security that they have done so much to earn.

STANDARD SILVER: ITS HISTORY, PROPERTIES AND USES.—I.

By Ernest A. Smith, Assoc.R.S.M., F.C.S.

At a very early period of the world's history silver was used as a medium of exchange, and also for domestic and public purposes.

Gold and silver appear to have been in general use as money from the time of Abraham, while vessels and ornaments of the precious metals were common in Egypt in the times of Usertsen I. (about B.C. 2433) and of Thothmes III. (about B.C. 1600), the contemporaries of Joseph and Moses.*

In ancient times the metals were used in their native or unalloyed condition, but alloys of definite composition or standard alloys were adopted for the purpose of coinage and also in the arts as early as B.C. 500, and probably earlier.

"The reasons for the use of alloys, in preference to pure metals, are somewhat complex. In early states of civilisation coins are generally made of more or less pure metal, but a nation does not advance far in its history before the very important fact is recognised that alloys are more durable than pure metals, and that their substitution for pure gold or silver affords a notable source of revenue.

"In cases where the coinage is in any degree international, the adoption of a low standard by one nation has to be followed by neighbouring nations, in order to prevent loss, and to facilitate commerce by avoiding the necessity for tedious calculations as to the rate at which coins may circulate in the respective countries."†

With regard to the actual standards of fineness or amounts of precious metal present in any given alloy which have from time to time been employed, it may

* Wilkinson's "Ancient Egypt," III., 225.

† Roberts-Austen, Cantor Lectures on "Alloys for Coinage," Society of Arts, 1884, p. 11.

be remarked that in the numismatic history of the world endless combinations of precious and base metals have been represented.

Gold and silver on account of their comparative softness and flexibility are never employed in a pure state, but are almost universally alloyed with a certain proportion of copper, the alloys being made up to definite proportions or "standards."

Although it is generally known that silver coins and plate are not made of pure silver, few people have very definite ideas as to the composition of the alloys which are employed for these purposes, and still fewer are aware that the amount of base metal added to the silver is guarded with the most rigorous care.

In the British Isles the proportion of silver in coin and plate is regulated by law. It is enacted that British silver coin and plate shall consist of 11 ozs. 2 dwts. of fine or pure silver and 18 dwts. of copper in the troy pound, or 925 parts of fine silver per 1,000 parts of alloy. This is termed sterling silver, and was first particularly defined by statute in 1576 (18th of Elizabeth, c. 15).

Many derivations have been offered with regard to the word sterling, but the most probable and the one now generally adopted is that given in a well-known old book entitled "A new Touch-stone for Gold and Silver wares," published in 1679. In this very interesting work the author states (on page 8) that the expression sterling-alloy is derived "from the Easterlings, or men that came from the East part of Germany in the time of King Richard the First, and who were the first contrivers and makers of that alloy." The purity of their money was famous, and it is supposed that coiners were fetched from Eastern Germany to improve the British currency.

Stow, writing in 1603,‡ gives a similar explanation. He says "the money of England was called of the workers thereof, and so the Easterling pence took their names of the Easterlings, which did first make this money in England in the reign of Henry II., and thus I set it down according to my reading in Antiquitie of money matters, omitting the imaginations of late writers, of whom some have said Easterling money to take that name of a starre stamped on the border or ring of the penie; other some, of a bird called a stare or starling stamped on the circumference, and others (more unlikely) of being coined at Striuelin or Starling, a town in Scotland."

With regard to the adoption of an alloy containing 11 ozs. 2 dwts. of silver in the pound troy as a standard for the silver currency of this country, Sir Roberts-Austen§ has pointed out that the adjustment of the relative proportions of the precious and base metals is undoubtedly guided by the particular system of weights used.

The fineness of alloys of silver has from very early times been computed by divisions of the troy pound, which weight is still retained in weighing gold and silver.

The Commissioners appointed in 1868 to enquire into the condition of the Exchequer Standards state that "the troy pound is said to have been derived from the Roman weights of [illegible] the 125th part of the large Alexandrian [illegible], like the troy pound having been divided [illegible] Romans into twelve ounces, and they add [illegible] universally allowed to have been in use [illegible] the time of King Edward I. The most ancient [illegible] of weights in this kingdom was that of the money [illegible] pound, or the money pound of the Anglo Saxons, which continued in use for some centuries after the Conquest, being then known as the Tower pound, or sometimes the goldsmiths' pound. It contained twelve ounces of 450 grains each, or 5,400 grains, and this weight of silver was a pound sterling. The Tower pound was abolished in 1527 by a statute of King Henry VIII., which first established troy weight as the only legal weight for gold and silver. From that time to the present our system of coinage has been based on the troy weight."

In connection with the standard 925, it may be remarked that a Roman silver coin of the Triumvir Antoninus* (B.C. 31) had almost the same composition as British silver coin, as it contained—silver 925, copper 71, lead 2, and gold 1.

The standard 925 was probably first introduced into England by the Saxons, as the Saxon pennies were of the same standard. A number of coins issued before the Norman Conquest have been assayed by Roberts-Austen,** from which the following results have been selected. A coin of Burgred, King of Mercia (852-874 A.D.), contained only 332 parts of silver in the thousand, while one of Ethelred (978-1016 A.D.) contained 918 parts of silver, and was probably intended to represent the standard 925. A coin of Canute (1016-1035 A.D.) proved to be of the standard 931, and was also intended, in all probability, to represent the English standard.

Anglo-Saxon and Anglo-Norman coins are believed to have been of the standard 925; a coin of William the Conqueror when assayed proved to be of the standard 922.8. In England the standard 925 appears to have remained unchanged until the thirty-fourth year of King Henry VIII. (A.D. 1542), when, as will be seen from the following table, a great fall in the fineness took place.

TABLE showing the Alterations in Fineness of English Standard Silver, from the reign of William the Conqueror to that of Edward VII.

Date.	Reign.	Fineness of Silver. In the Pound Troy.		Fineness of Silver. Parts per 1000.
		ozs.	dwt.	
1066	William I.	11	2	925
to	to			
1542	34 Henry VIII.	10	0	833.3
1545	36 Henry VIII.	6	0	500
1546	37 Henry VIII.	4	0	333.3
1547	1 Edward VI.	4	0	333.3
1549	3 Edward VI.	6	0	500
1550	4 Edward VI.	3	0	250
1551	5 Edward VI.	5	0	416.6
1552	6 Edward VI.	11	1	921
1553	1 Mary	11	0	916.6
1560	2 Elizabeth	11	2	925
to	to			
Present Time	Edward VII.	11	2	925

‡ "A Survey of London," by John Stow, p. 52, 1603. Quoted by Roberts-Austen, p. 14. *Ibid.*

§ *Ibid.* Cantor Lecture, p. 15.

‖ Third Report of Commissioners. Parliamentary Paper, [illegible], 1870.

* [illegible] Metallurgie [illegible] A. Ledebur, p. 86, 1882.

** *Ibid.*, Cantor Lecture, p. 17.

The table shows that in 1545 the standard alloy contained only one-half of its weight of pure silver, and in 1550 it was still further debased, and contained only one-fourth part of pure silver. The restoration of the silver standard, begun in the reign of King Edward VI., was completed by Queen Elizabeth, and it has not been since debased. (*To be continued.*)

THE TYPES OF SUN-SPOT DISTURBANCES.

By the Rev. A. L. Cortie, S.J., F.R.A.S.

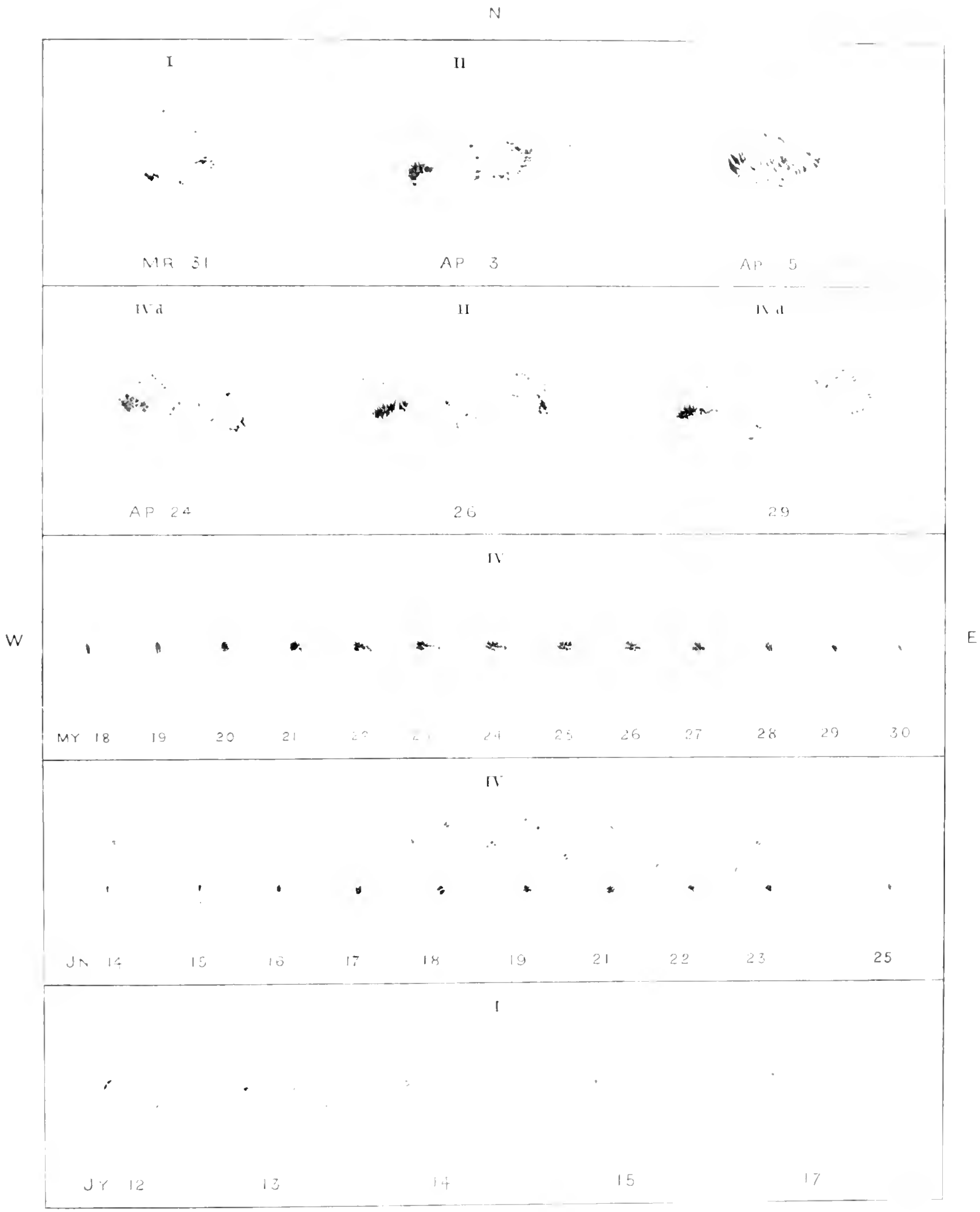
During the last twenty years some 3800 drawings of the solar surface, on a scale of 10½ inches to the sun's diameter, have been made at the Stonyhurst College Observatory, during the period 1880 to 1890 by means of the 8-inch equatorial, and since the latter year by means of the Perry Memorial 15-inch equatorial. The principal spots in this long series of drawings have recently been tabulated in a form which gives their complete life-histories from their first appearance to their final extinction. Accompanying the tabulations, are a series of charts which show at a glance the chief phases in the development of a group of spots. The object of these tables and charts was to compare individual spots on the sun and magnetic storms on the earth, and the results of the comparison were presented by Father Sidgreaves to the Royal Astronomical Society last December. But besides this primary object for which the tables and charts were drawn up, they have served, and, it is hoped, will serve for many other subsidiary studies with regard to sun-spots. One such study led to a paper read at the last meeting of the British Association at Bradford, of which some account is presented in the following pages. It is comparatively easy from the charts, not only to study the changes in individual spots which take place during their appearance on the sun, but likewise to compare outburst with outburst. From this comparison it was soon seen that there exists a great family likeness between all outbursts of sun-spots, whether we deal with the great storms when the solar activities reach their maximum, or the feeble manifestations of the solar forces at the epochs of minimum. Should an observer look at the sun at a time of maximum activity, he will probably see its surface covered with many spots seemingly in all sorts of forms and shapes; as scattered dots, or as trains of spots, or in a form in which two larger spots predominate in a group, or again as a single deep black spot, of round and regular outline. Yet all these varieties are but phases of one well-marked and general type through which, as a general rule, all groups of spots pass during the course of their life-histories. In a normal outburst the sequence of the phases is as follows. We must premise, however, that in short-lived spots all the various stages or phases of the type may not be reached, but only the earlier ones.

A group of spots first appears in the form of a few scattered dots or small spots. These spots grow with great rapidity, and in three or four days at the most after their birth, begin to aggregate, and reach a second characteristic phase in the process of development. This is marked by the predominance of two main spots in the group, one in the forefront, and the other in the very rearmost position of the group. In this phase the preceding of the two spots is for the most part the more compact and regular, its fellow being generally irregular and ragged in form, and made up of semi-detached patches of umbra and penumbra. Many times, however, it covers a greater total area than the leader of the group. This stage is reached by almost all groups of spots, even very small ones, and any theory as to the origin and development of sun-spots must needs explain why two spots, one in the forefront and one at the rear of the group should always predominate. The preceding of the two main spots, as a rule, then, rushes forward with a large proper motion in longitude, by this means increasing its distance from the rearmost spot. At this period in the life-history of the group, the space between the two spots becomes filled by a train of irregular unformed spots, and penumbral patches of no very great size, the whole train of spots thus formed arranging itself into a stream more or less parallel to the solar equator. This type is accordingly reckoned as the third in the order of succession in a normal outburst. It occurs ordinarily between five and seven days after the first appearance of the group. At times a retinue of companion spots follows both the chief members of the group, and more rarely is confined to the rearmost spot. This phase is not very stable or of long duration, and the two main spots survive after its disappearance. Hence there is a recurrence from the third type back again to the second. Of the two surviving spots the following one generally breaks up and disappears in a few days, leaving the leader to form into a dense black round spot of regular outline. This accordingly has been reckoned as the fourth type or phase in the stages of the life-history of a group of spots.

Although it is the leader that generally survives to form the single spot, yet instances are not wanting in which the reverse has been the case, the leader disappearing and the rearmost of the two spots remaining (*e.g.*, 1892, July 4—October 5). A few cases are on record when both the chief spots survived to form regular spots (*e.g.*, 1881, October 14—December 17). Again, the single surviving spot, accompanied or unaccompanied as the case may be by small companions, may never become a round regular spot, but may maintain an irregular shattered appearance of a collection of umbræ and penumbræ, as for instance in the great spot of February, 1892. The duration of the phase in which the group has developed into a single round black spot is generally for two solar rotations, and in one case (1897, April 28—August 27) was maintained for five successive rotations. It may be remarked in passing that the average life of a group of sun-spots, derived from a study of 115 greater disturbances recorded at Stonyhurst during the last twenty years, is 56 days, or a little longer than two solar rotations.

The last stage in the life-history of a group of sun-spots is reached when the round black spot gradually dwindles down to the dimensions of a mere dot, or disappears as a group of small dots. This phase is so like the opening phase of the series that it does not need a new type number to describe it. It frequently happens that when this final stage has been reached, other smaller spots will appear in the neighbourhood of the remnants of the storm that is passing away, and the whole cycle of phases will be again repeated. A series of outbursts linked together in this manner in approximately the same position on the solar disc was active during a period extending from September 25, 1891, to March 5, 1893, or during more than twenty solar rotations.

In addition to these four well-marked phases or types described above, another type comprises irregular, scattered groups, of short life, which occasionally appear and disappear without conforming to the normal sequence of changes.



LIFE HISTORY OF A SUNSPOT GROUP. ILLUSTRATING FOUR TYPES.

Slight variations from the normal types, or subdivisions of the same, have so far been indicated by placing letters after the four type numbers.

The illustration, which shows not only the four types, but their sequence, is that of a large sun-spot group which first appeared on the sun on March 31, 1884, and lived for 108 days to July 17, passing the central meridian five times. The five horizontal sections of the plate correspond to the five rotations. The spot group was born at the centre of the visible disc on March 31, when it appeared as a few scattered dots, the first phase or Type I. of our divisions. By April 3 it had reached the phase, designated by Type II., when two main spots predominated. Thus it continued until the 5th, when the train appeared between the two spots, corresponding to Type III. On April 6th it was near the sun's western limb which it passed on the 7th. At its return it was first recorded on the 22nd, appearing on that date and on the three following days as an elongated single spot with a train of smaller companions. This phase is represented by one of the subdivisions of Type IV. On April 26th and the following day it had reverted to Type II., and on the 28th, 29th, and 30th to Type IV., subdivision *d*. Thus it remained until it again passed the western limb on May 4th. At its next two returns, when it was followed during each of the thirteen days that it was visible, it had become a single round spot, the normal spot of Type IV. It will be noticed that during the fourth appearance a small subsidiary group formed to the north of the original group, and that even in this small outburst the two spot type is evident. At its fifth appearance, when it was gradually disappearing, it had resumed the phase which belongs to Type I. A closer examination of the series of phases represented on the plate will show many other interesting points, as for instance the formation of tails to the leading spot of the group, and the narrowing of the penumbra on the side of the spot turned towards the sun's centre in rotation the third, even before it had reached a position near the limb where the effect of perspective would have been apparent. The illustrations are drawn to a scale of 10½ inches to the solar diameter.

In a subsequent paper the relation of faculæ to sun-spot groups will be dealt with.

CONSTELLATION STUDIES.

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

V.—THE SCORPION AND THE SERPENT-HOLDER.

How many constellations did the original Chaldean Zodiac contain,—eleven or twelve? The question is a very important one as bearing on the origin of the Zodiac, since the twelvefold division is significant of the ancients having determined the length of the year at least approximately before the constellations were mapped out.

The assertion that the Chaldean Zodiac consisted originally of only eleven constellations is made explicitly by Servius the grammarian in his commentary on the works of Virgil. The latter in his address to the Emperor Augustus, in the first Georgic suggests that the space which lies between the Virgin and the following Claws, lies vacant for him; "the glowing Scorpion drawing back its arms and leaving for him a more than ample space of sky." Our Greek authorities, however, made the signs of the Zodiac twelve in number, but gave to one of the t[illegible] place, the Scorpion occupying one sign with [illegible] and another with its outstretched Claws. B[illegible] of this double honour given to the poisonous [illegible] very ingenious. Quoting from Aratus, he point[illegible] old legend of how Orion was slain by a gigantic [illegible] in punishment for his attack upon Artemis:

> "And great Orion, too, h[illegible] the Scorpion [illegible]
> Content thee, Artemis! A tale of old
> Tells how the strong Orion seized thy robe
> When he in Chios, with his sturdy mace
> A hunter, smote the beast to gain Œnopion's thanks
> But she forthwith another monster bade
> The Scorpion having cleft the island's hills
> In midst on either side: This, huger still,
> His greatness smote and slew, since Artemis he chased.
> And so 'tis said that, when the Scorpion comes,
> Orion flies to utmost end of earth."
>
> (Brown's *Aratus*.)

Orion, the most gorgeous of all the constellations, is, according to this theory, a stellar representation of the sun; the Scorpion, on the other hand, represents the night and the power of darkness. "As the huge size of Orion, *i.e.*, that of the sun as compared with the stars, is always insisted on, so the scorpions of darkness are of colossal size, infinitely greater than the Orion sun." The gigantic size of the Scorpion, therefore, was insisted on by bestowing on it a double portion of the Zodiac.

Our present name for the seventh constellation of the Zodiac, Libra the Balance, we owe to the Romans, Virgil writing in the first Georgic:—

> "Libra die somnique pares ubi fecerit horas."

but we cannot now say how far back into antiquity the symbol goes. Though as Aratus truly says,

> "Few are its stars for splendour and renown."

The constellation Libra can be readily found by an alignment from Arcturus:—

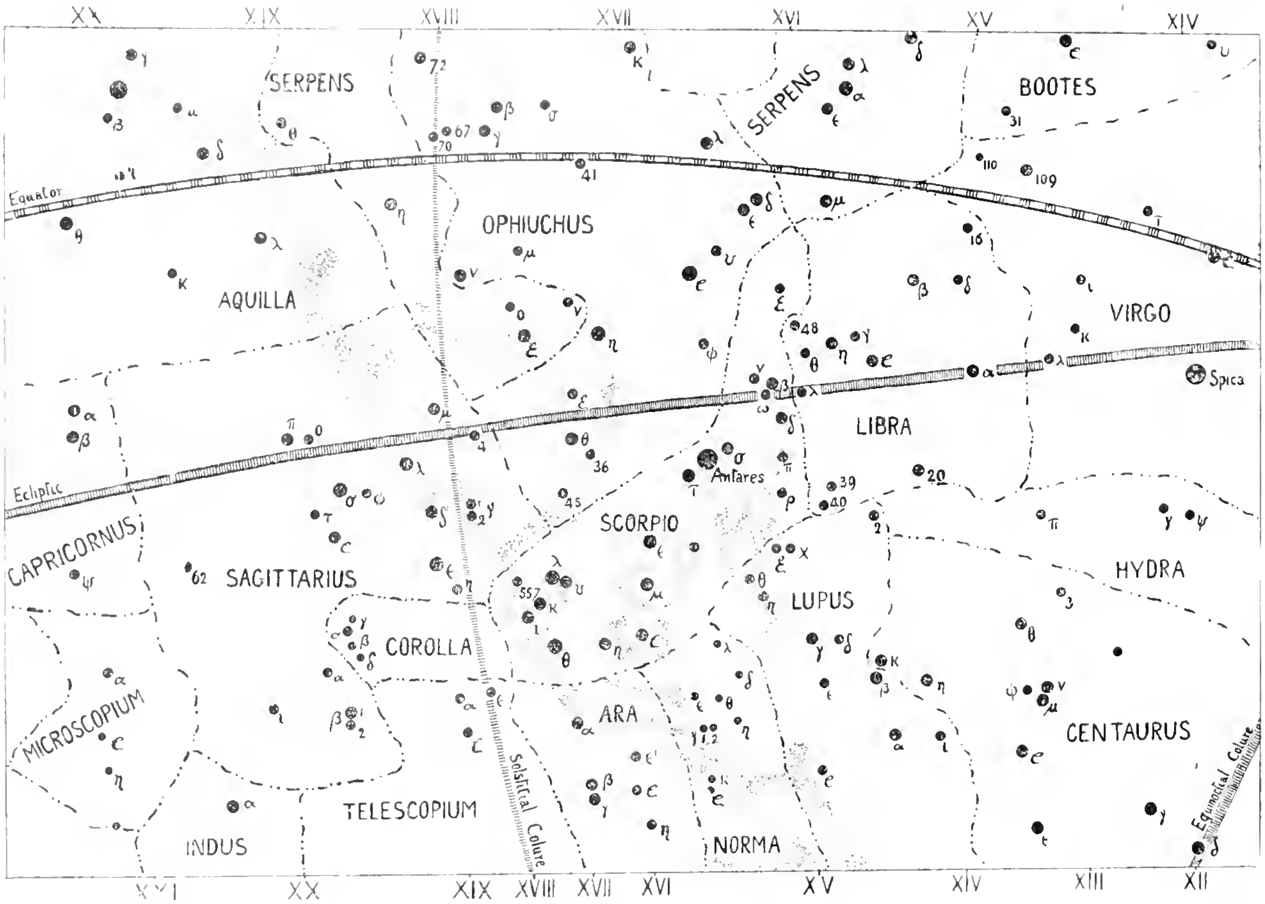
> "Where yon gaunt Bear disports a tail, seek Alkaid at its tip,
> From thence a ray athwart the space to south-south-east must dip:
> And when Arcturus has been passed prolong th' imagin'd line,
> 'Twill mark a star, as far again, the first in Libra's sign."

Alpha Librae is an unlucky star as to its name; it really should be Zuben el Genubi, the southern claw; but it is often called Zuben el Chamali, the northern claw, a title which clearly belongs to Beta Librae. The star marks the ecliptic almost exactly, and it forms a very pretty double to the opera-glass.

Beta Librae, forming an equilateral triangle with Alpha Librae and with Mu Virginis, is a star with a markedly greenish colour, and interesting history. For Eratosthenes calls it the brightest of all the stars in the Scorpion, that is in the double constellation, and Claudius Ptolemy gives it as equal with Antares. As it is now a full magnitude fainter than Antares it must have faded greatly.

But passing on to the Scorpion proper, we come to the finest region of the sky as seen in southern realms. There is no difficulty in tracing out the Scorpion. Antares, its brightest gem, is almost exactly as far beyond Spica as Spica is beyond Regulus; and Arcturus, Spica and Antares, make up a magn[illegible] angled triangle, Spica marking the right angle. Antares stands in a long and beautifully win[illegible] made of bright stars, which mark out the [illegible] reverted sting of the reptile, and faint [illegible] right and left show its legs. "There are f[illegible] constellations," as Serviss truly remarks, "which [illegible] so close a resemblance to the objects they are named after as Scorpio." It does not require a very violent exercise of the imagination to see in this long winding trail of stars, a gigantic scorpion, with its head to the west, and flourishing its upraised sting, that glitters with a pair of twin stars, as if ready to strike."

The pair of stars in question are Lambda and Upsilon, Lambda being the brighter. To the north and east of this pair of stars, and about 6° distant from Lambda, are two star clusters about 4° apart—6 and 7 Messier, —we come in turn to Tau, then after a gap to Epsilon, and then to Mu Scorpii, a lovely pair in the opera-glass, whilst the next star lower down in the curve, Zeta, gives a region of most exceptional beauty to a good binocular. To the English observer, Scorpii hugs the horizon too closely for the full magnificence of the region to reveal itself, but for those who are favoured with a more southern residence, the Milky Way attains



Star Map No. 5. The Region of Scorpio.

both well worth examination with the opera-glass. Turning back to Antares, the bright star to the west of it is Sigma, and almost between Sigma and Antares, but a little below, is another star cluster, number 4 in Messier's catalogue. The entire constellation is full of interesting and beautiful fields even for so slight an optical assistance as the opera-glass gives. The two principal stars in the forehead of the Scorpion are Beta the more northern, Delta the more southern, distant from Antares roughly one-third the way to Beta and Alpha Librae. Immediately below Beta is the bright and pretty pair, situated on the ecliptic, Omega Scorpii, whilst Nu Scorpii, a little above and following Beta, is also a double, but requires a more powerful lens to show it as such. Immediately above Antares is 22 Scorpii, a star with two companions; Rho Ophiuchi a little further north, has also a couple, both within the grasp of the opera-glass.

Following the curve of stars downwards from Antares, —which by the way owes its name to its pronounced red colour, the reddest bright star in the sky, and, therefore, fitly called Antares, the rival of Ares or Mars, here its greatest glory and its most striking complexity of form.

The old constellation makers have left evident proof in this portion of the sky that they were not working haphazard in the designs they selected for the star groups, and the places which they assigned to them. At midnight at the spring equinox, the Scorpion was for them on the meridian in the south, and the Dragon was in like manner on the meridian low down in the north. Just as they had planted the Kneeler, whom we now call Hercules, upon the Dragon in the north, so they provided another hero, the Serpent-holder, to trample down the Scorpion in the south, and the heads of the two heroes were made up by the stars in the zenith. Both the unknown warriors, therefore, were pictured in those primitive ideas as erect, but for many generations Hercules has been to us hanging head downwards in the sky in the most uncomfortable of attitudes, for our zenith, nowadays, passes nearly through his feet.

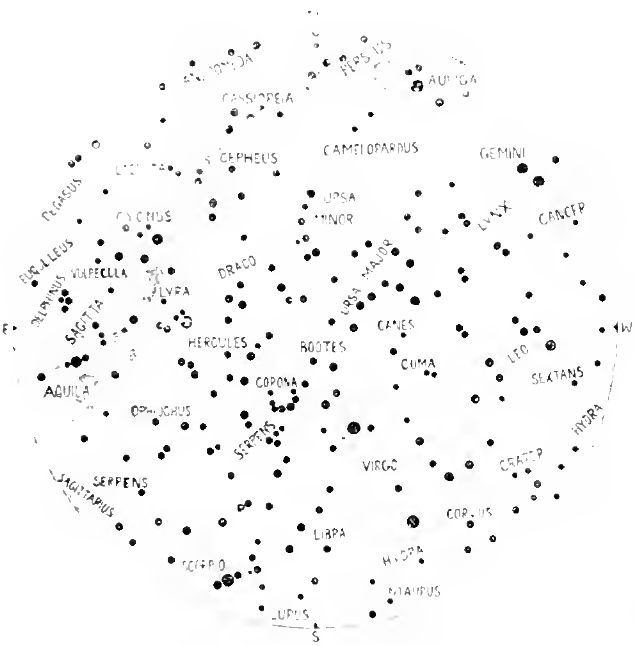
Although the conqueror over the Scorpion, Ophiuchus is not for a moment to be compared with his enemy as a constellation. It covers a great extent of sky, its stars are none of them of the first rank, and are not disposed in any easily followed figures. Its principal star, Alpha, Ras-al-Hague, "the head of the serpent charmer," lies midway between Vega and Antares, as the old rhyme has it :—

"Through Ras al Hague, Vega's beams directs the enquiring eye
Where Scorpio's heart, Antares, decks the southern summer sky."

Ophiuchus is engaged on a double labour. Aratus describes him thus :—

"His feet stamp Scorpio down, enormous beast,
Crushing the monster's eye and platted breast
With outstretched arms he holds the Serpent's coils,
His limbs it folds within its scaly toils;
With his right hand, its writhing tail, he grasps;
Its swelling neck, his left securely clasps.
The reptile rears its crested head on high
Reaching the seven-starred Crown in northern sky."

The head of the serpent is marked out by five stars in the shape of a capital X, immediately below the semi-



The Midnight Sky for London 1901 May 6

circle of the Northern Crown. The five stars are Beta and Gamma at the feet of the X, Kappa in the centre, and Iota and Rho at the top. The small stars clustering near this X of the Serpent's head make an interesting field to the opera-glass, but the tip of the tail, marked by the star Theta, is more interesting still. Theta may be found by drawing a line from Beta Herculis through Alpha Ophiuchi, and it is situated in a striking channel in the Milky Way, one side branch of which comes to an end just on the borders of Ophiuchus.

THE NEW STAR IN PERSEUS.

The following is an abridgement of Harvard College Observatory Circular No. 56:—The cable message announcing the discovery of a new star in the constellation Perseus, by the Rev. T. D. Anderson, was received at the Observatory early in the evening of February 22, 1901. Owing to clouds, the new star was only occasionally visible, and twice it was necessary to cover the instruments on account of rain or snow. During the intervals, however, various observations were made which have a value owing to the early date.

Meanwhile, an examination was being made, by Mrs. Fleming, of the photographs of this region obtained here earlier in the month, with the various instruments. The photograph taken with the Cooke lens on February 19 had an exposure of 66m., beginning at 11h. 18m. Greenwich mean time. While this photograph showed not only the faintest stars contained in the Durchmusterung, but also stars as faint as the eleventh magnitude, no trace of the nova was seen. A photograph taken with the 24 inch Bruce telescope on October 18, 1891, with an exposure of 15m., shows no trace of this object, although stars as faint as the magnitude 12.5 are well seen.

The general appearance of the photographic spectrum (on February 22) resembled that of the Orion type and was very unlike that of the other new stars, in which the bright lines are the most conspicuous feature. This star had a long continuous spectrum traversed by 33 dark lines. On careful examination the lines 3970, 4102, 4341, 4481, and 4862 were seen to be bright on the edge of greater wave length. The line 4665 was bright on the edge of shorter wave length, or there was a bright line whose approximate wave length was 4660. On February 23, the clouds were so dense that few observations could be made. The spectrum was photographed faintly and showed no marked change except that the line K, which was absent on the previous evening, was present and nearly as intense as Hε. On February 24 the spectrum showed a remarkable change. It was traversed by numerous bright and dark bands, and closely resembled that of Nova Aurigae. The principal lines were dark with accompanying bright lines of somewhat greater wave length. The bright lines accompanying K and Hε were reversed, and traversed by narrow well defined dark lines. These last lines, and one of somewhat shorter wave length than Hβ, are the only sharply defined lines in the spectrum, all of the others being broad and hazy, and difficult to measure with accuracy. On February 25 the spectrum differed slightly from that of February 24. The lines Hδ, Hγ, and Hβ were also reversed and replaced by one or more narrow dark lines. On February 26 the changes in the spectrum were slight.

Observations of the position of the nova were made by Mr. J. A. Dunne, with the 8 inch meridian circle, on February 23, 24, and 25, with the result for 1900.0, R.A. 3h. 24m. 24.02s., Dec. + 43° 33′ 42.4″.

It therefore appears that on or before February 19, 1901, the star was invisible, or at least fainter than the eleventh magnitude. On February 21, its magnitude was 2.7, according to Mr. Anderson. On February 22, its magnitude was 0.5, perhaps becoming a little brighter on February 23, and then diminishing, so that on February 25 its magnitude was 1.1. Its spectrum on February 22 and 23 was of the Orion type, nearly continuous, traversed by narrow dark lines. During the next 24 hours an extraordinary change took place, so that on February 24 the spectrum resembled that of the other novæ. It was traversed by bright and dark bands, and the principal dark lines had accompanying bright lines of slightly greater wave length.

During the last fourteen years, and since the general application of photography to astronomy, eight new stars are known to have appeared: Nova Persei, in 1887; Nova Aurigae, in 1892; Nova Normae, in 1893; Nova

Carinae, in 1895; Nova Centauri, in 1895; Nova Sagittarii, in 1898; Nova Aquilae, in 1899; and Nova Persei in 1901. The second and last of these, which were much brighter than the others, were found visually by Dr. Anderson. All the others were found by Mrs. Fleming, from an examination of the Draper Memorial Photographs. EDWARD C. PICKERING.

In Harvard Circular No. 57, Prof. Pickering gives reproductions of photographs of a part of Perseus, one taken before the appearance of the nova and another when it far outshone all other stars in the field. The great change in the spectrum which took place between February 22 and 24 is also very forcibly illustrated by copies of the spectra photographed on these dates.

Numerous photographs have been obtained at the Yerkes Observatory, but details of the measurements have not yet been published. From a preliminary examination, Prof. Hale appears to be inclined to attribute the three principal green lines near F to the two nebular lines and magnesium *b*, but Sir Norman Lockyer considers that during the early stages these were really due to iron vapour at a high temperature.

The observations of magnitude which have been made by various observers indicate very remarkable fluctuations in the brightness of the new star. The rise from invisibility was even more rapid than could be assumed from the evidence of the Harvard plates. It fortunately happened that the region of the nova was photographed by Mr Stanley Williams only 28 hours before the discovery by Dr. Anderson, and at that time the star was certainly below the 12th magnitude. The star thus probably rose not less than $12\frac{1}{2}$ magnitudes within three days, corresponding to a multiplication of its light by 100,000 times.

From the time of maximum brilliancy on February 23 the decline was pretty rapid until about March 13 when the star was not far from 4th magnitude; then until the 17th there was a slow reduction to about 4.2, and the star remained near this until March 31st, except that on the 19th, 22nd, 25th, and 28th it went down to nearly 5.5. Thus, for a short time the star was a more or less regular variable, with a well-marked period of about 3 days. The expected recurrence of a minimum on March 31st, however, was not observed, but the oscillation has since been continued with a somewhat greater period and larger range of light changes. On account of these rapid changes it does not seem desirable to attempt the construction of a light curve until all the observations have been collected, and intending observers will see the importance of noting the hour as well as the day of observation

The continued spectroscopic observations are of the utmost importance. Sir Norman Lockyer states that between the 10th of March and the 25th the photographic spectrum had greatly changed Besides the persistent lines of hydrogen, there were lines due to helium, and others possibly identical with some of the lines in the spectra of bright line stars and nebulæ, the bright lines other than those of hydrogen seen in the earlier photographs having disappeared. In the visual spectrum it was observed that while the whole was becoming enfeebled, the bright hydrogen lines remained the most prominent feature, the other lines previously visible being much reduced in intensity, and apparently also being replaced by new ones, among which was a line in the orange (possibly D_3 replacing D). Another line in the green, near λ 501, which became relatively brighter, was probably the chief line of the nebular spectrum. A preliminary reduction of a photograph of the changed spectrum is thus described by Sir Norman Lockyer :—

λ 387 Broad and merging into Hζ 3889.
436 Faint.
447 Not very strong. Probably helium 4471.6.
456 Faint.
464 Very strong broad line. Possibly the 465 line of the bright line stars.
468 Moderately strong. Possibly new hydrogen, λ 4686, seen in bright line stars.
471 Weak. Probably helium, λ 4713.

The lines of hydrogen shown in the photograph were Hβ, Hγ, Hδ, Hε and Hζ. These exhibited a structure quite different from that shown in the earlier photographs, and the place of maximum intensity had changed from the more to the less refrangible side of the line in each case.

It thus appears that the spectrum has already exhibited three distinct phases. In the first (February 22 and 23) dark lines on a strong continuous background were the most prominent feature, and there is evidence that those not due to hydrogen and helium were high temperature lines of various metals. The second stage (February 24 to March 10) corresponded very closely with that of Nova Aurigæ before its assumption of the nebular condition, the spectrum consisting of bright and dark lines, and many of the bright lines having dark ones on their more refrangible sides. At the third stage, which commenced somewhere between March 10 and March 25, the spectrum consisted chiefly of bright lines, some of which were probably identical with lines which appear in the spectra of nebulæ and bright line stars. Father Sidgreaves appears to have discovered variations of spectrum accompanying the changes of magnitude which have occurred since the middle of March, but details are not yet available. In the case of Nova Aurigæ, only the second of these stages appears to have been recorded, the transition to the more complete nebular condition indicated by the third stage of Nova Persei either having been very sudden or having escaped detection from other causes.

It will thus be seen that there is every reason to hope for great additions to our knowledge, when full details of the observations become available for discussion.

A. F.

Letters.

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

SUNSPOTS AND TERRESTRIAL TEMPERATURE

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In comparing the temperature-tables for the last 20 years, I have been struck by the fact that our temperature is surprisingly dependent on the number of sunspots on the sun. The winters during and after a sunspot minimum are notably colder than the average, while the winters during and after a maximum are on the whole of a mild nature. Now presuming that this is not an accidental coincidence, which it seems to me is most improbable, as during the last 50 years the same striking connection meets us nearly everywhere, the cause of this mysterious connection seems very inexplicable according to the hypothesis that solar spots are excavations in the sun, produced by an eruption of gases, which become highly condensed, and therefore appear to our eyes as dark spots. In that case these spots would in no way send forth any extra quantity of heat, on the contrary, they would diminish the heat-giving surface of the photosphere. But according to all statistics this by no means agrees with our observations.

Now I saw in the November number of Knowledge for 1900, p. 254, that Baron Kaulbars had brought forth a new hypothesis on the nature of solar spots. The Baron indicates that as the sun's temperature in all probability rises the deeper one descends, "the lower 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 range of sensibility of our optic nerves, and therefore appear black." If this be the case, it gives a simple explanation of the rise and fall of the temperature of our seasons, in accordance with the sunspot cycle. At a maximum the large amount of spots would send forth an excess of heat, and at a minimum the sun's temperature would be normal.

Of course our temperature is subject to manifold terrestrial disturbances, wherefore no absolute regularity can be expected to be attained in evidence of a close connection between the sunspot cycle and our waves of heat and cold, but still the above statements seem to afford some degree of presumption as to the likelihood of such a connection. Percy Quensel, F.R.A.S.

Upsala, Sweden.

[Mr. Quensel states that he has "been struck with the fact that our temperature is surprisingly dependent on the number of sunspots." It is much to be desired that Mr. Quensel should give the actual figures on which he bases this statement. Right or wrong, it is not a statement that can be accepted on anyone's *ipse dixit*, but we do need most sorely the fullest and fairest possible comparison of temperature records with the observed sunspot curve. It must be borne in mind that if the spots radiated absolutely no heat whatsoever yet the change from the maximum to minimum would hardly mean a change of one-tenth per cent. in the solar radiation. Now we know that the radiation from a spot is very considerable. The radiation from the faculæ—most numerous when spots are most numerous—is probably in excess of that from the photosphere. We may take it then that the extreme variation from dead minimum to most active maximum in the total radiation of the sun is not likely to exceed one part in ten thousand. One would scarcely expect that so small a change would produce a very marked result upon our temperature curves. If Mr. Quensel has a clear case of such connection, we should certainly be glad to see it.

E. Walter Maunder.]

THE NEBULAR HYPOTHESIS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Mr. Walter Maunder's observations in the April number of Knowledge are certainly not in accordance with the theory propounded by Laplace. I have always been given to understand that Neptune, if that body really determines the boundary of the solar system, was the first planet to be detached from the parent mass which was then (supposed to be) in a rapid motion of rotation about a central axis. If this state of things represents the true facts, [illegible] Neptune is the youngest of the planets, and not the [illegible], as Mr. Maunder seems to suggest. [illegible] Knight.

7, Sydenham Terrace, [illegible]

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Perhaps I may be allowed to refer your correspondent Mr. Christopher to Trowbridge's explanation of the anomalous rotation of Uranus and Neptune, as given on pp. 570 and 571 of the new edition of Professor Young's "General Astronomy," as affording to my mind a more simple and rational explanation of the difficulty than that furnished by Faye's more involved one.

William Noble.

Forest Lodge, Maresfield, Uckfield.

It may be pointed out that Mr. Maunder, who has proceeded to Mauritius to observe the coming solar eclipse, simply quoted Faye's modification of the nebular hypothesis as a possible way of explaining some of the facts which have come to light since the time of Laplace, and is in no way responsible for the suggestion that the interior planets are the oldest, as Mr. Knight's letter seems to imply. On the contrary, it was remarked that there were very considerable difficulties attaching to Faye's form of the theory.

The explanation to which Captain Noble draws attention will also be found in the first edition of Young's "General Astronomy," pp. 518, 519. The substance of it is that when a ring has been detached and concentrated into a single mass, the direction of axial rotation will depend upon the original distribution of matter within the ring; if of uniform density, the rotation would be retrograde, but if it were most dense near the inner edge, the rotation would be direct. Prof. Young goes on to say: "The fact that the satellites of Uranus and Neptune revolve backwards is not, therefore, at all a bar to the acceptance of the nebular hypothesis, as sometimes represented."—Eds.]

CONSTELLATION STUDIES

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I have been very much interested in Mr. E. Walter Maunder's "Constellation Studies" in your valuable paper, and would like to ask two or three questions, trusting to receive a reply through your columns.

In the February number, Mr. Maunder, writing of the Constellation Leo, says that "Gamma, Zeta and Epsilon are all interesting as opera-glass objects from the companions which a slight optical assistance brings into view." The Rev. T. W. Webb, in his list of double stars, gives the distance of the component stars of Gamma Leonis as only 2·5" apart. Would an opera-glass split this star?

On looking at Captain Smythe's "Bedford Catalogue" I find the two stars of Epsilon Leonis are only 1·9" apart. Surely no opera-glass could divide these?

The smaller of the component stars of Epsilon Leonis is of the 10th magnitude only. Could this be seen with an opera-glass, even if the distance from the larger star were greater? Would not the light be much too dim?

In the March number Mr. Maunder says that "Zeta Corvi, the faint star midway between Epsilon and Beta (Corvi), shows with the opera-glass as a very interesting double." Now the smaller star of this pair is 13·5 magnitude. I should like Mr. Maunder to say whether it would be possible to see a 13·5 magnitude star with an opera-glass, whether indeed it would not be a difficult object for a small telescope? Ernest L. Bilby.

West Bridgford, Notts.

[The "companions" mentioned by Mr. Maunder in connection with the stars to which reference is made by Mr. Beilby, are small adjacent stars, and not the "components" shown when large telescopes are employed. Certainly no opera-glass would divide stars 1·9" or 2·5" apart, nor could it be expected to show stars of the 10th magnitude. An aperture of at least 10 inches would be required to see a star of magnitude 13·8.—EDS.]

Notices of Books.

"THE PROGRESS OF INVENTION IN THE NINETEENTH CENTURY." By Edward W. Byrn, A.M. (New York: Munn and Co.) Illustrated. 3 dols.—This book compels our admiration. Beautifully printed on excellent paper, and very tastefully bound, it is a pleasure to behold. The illustrations too, are good and most interesting, comprising, as they do, pictures of the people of 100 years ago engaged in various mechanical pursuits. The author realising the limitations of his work, states in his preface that "The work cannot claim the authority of a text book, the fulness of a history, nor the exactness of a mechanical treatise." Under the heading "Chronology of leading events" we have, 1800, Volta's chemical battery, and Roberts' machine for making continuous webs of paper. In 1801, Trevithick's steam coach, and so on. Of the telegraph we are told, "On May 24th, 1844, there went over the wires between Washington and Baltimore the first message, 'What hath God wrought?'" This is, of course, an error, for as far back as 1820 Fletcher made use of his electro-magnetic telegraph. But the rest of this chapter is accurate and interesting. Under "The Dynamo and its Applications," we are, of course, not justified in expecting anything other than the well-known history from Pixil's work in 1832 to the machines of to-day. Next, from the description of Barlow's wheel, we are taken, by easy stages, to some account of the modern Westinghouse motor, and, turning the pages again, we go from the Jaberkoff candle to the search-light on Mount Lowe. Under "The Steam Engine," we have a description and picture of Hero's engine, assigned to the year 150 B.C. Turbines, the Nasmyth hammer, and the modern fire engine, are all depicted and described. Locomotives and Atlantic liners, printing presses, and paper machinery, are all pleasantly discoursed of. The typewriter, sowing and sewing machines, refrigerating apparatus, and motor cars, are all adequately represented, as also the bicycle at various stages of its evolution. Telescopes, cameras, radiographic apparatus, and gas plant, all make way for the Forth Bridge, which is followed by the Suez Canal, the Eiffel Tower, and Washington's Monument, wood and metal working appliances and firearms. Our author concludes with an excellently well-written "Epilogue," and we lay the book down wishing that we might have ever so brief a look into any similar work which may be published in A.D. 2000.

"MICHAEL FARADAY: HIS LIFE AND WORK." By Prof. S. P. Thompson, F.R.S. (Cassell and Co.) Illustrated. 2s. 6d.—A hackneyed verse of Longfellow's "Psalm of Life" forces itself upon the mind when a book like the present comes before us. For to a student of science, or anyone having a mild interest in natural philosophy, the life of a man like Faraday is an inspiration. And when such a biography as his is available at the low price of this one, it is almost justifiable to say that the possession of the book should be everyone's desire. The general facts of Faraday's career are well known. How he attended Davy's lectures at the Royal Institution while a bookbinder's apprentice; how he brought himself under Davy's notice and was appointed to a minor post in the Institution, from which position he rose to be the leader of British science and the beacon of his time—all these facts are common knowledge. The story is told by Prof. Thompson in a most sympathetic manner, and there is scarcely a page of the book that does not contain some interesting incident or expression of opinion. There are few men whose lives will bear such minute analysis as that of Faraday, and none a student of science could more profitably keep before him. When we read how Davy treated the assistant whose researches had excited the admiration of the whole scientific world, a spirit of indignation fills the mind, and it is difficult to admire the genius of a man who could play such a part. The unpleasant light in which Davy's action can now be seen should be taken to heart by the men of science in power in the present generation. There may not be many Faradays, but there are certainly a number of Davys who endeavour to keep their assistants, however capable they may be, in subordinate positions. Faraday was above all petty meannesses and minor jealousies of this kind, and his life was one which should be widely known and emulated.

"THE STRUCTURE AND LIFE-HISTORY OF THE HARLEQUIN FLY (CHIRONOMUS)." By Prof. L. C. Miall, F.R.S., and A. R. Hammond, F.L.S. (Clarendon Press.) Illustrated. 7s. 6d.—This is not a book which appeals to a large public, yet it is a very valuable one, and will take rank as an important contribution to natural history. The work is very appropriately published by a University Press, and we trust that many similar monographs will be made available. What are popularly known as blood-worms are the larvæ of the gnat-like flies often seen in summer on window-panes, or hovering in swarms over streams and pools. This is the insect the life-history of which is traced by the authors in detail. To the practical man, it may appear a waste of time and money to prepare and publish a work upon the structure and habits of a trivial insect, but if he were familiar with the working out of the connection between malaria and mosquitoes he would pause before giving expression to this view. If the life-histories and internal structure of the various mosquitoes had been thoroughly studied, the connection between the insect and the disease would have been understood long before it was. In the same way Chironomus is possibly connected with occurrences in nature which affect the well-being of the human race directly or indirectly, and, leaving the biological value of the monograph upon it out of consideration, the time will probably come when its practical significance will be understood. From another point of view the book is valuable. There is a tendency to consider it an achievement to add to the number of species, while the study of the life-histories of insects is neglected. The monograph should encourage a more scientific spirit among the members of natural history societies, and lead to the preparation of works of a similar character. How wide is the field may be judged by the remark that "The great majority of Dipterous insects, for instance, have never been reared, and only an insignificant minority have been closely examined." We venture to say that a large part of the book will provide a naturalist with novel and interesting information, and will suggest similar observations of other insects, as well as create a desire to examine practically the facts described. If local natural history societies will encourage work on these lines they will do a real service to biological science.

"THE TEMPLES AND RITUAL OF ASKLEPIOS AT EPIDAUROS AND ATHENS." By Richard Caton, M.D. (C. J. Clay.) Illustrated. 3s. net.—Among the interesting results of archæological research in Greece is the information obtained as to the sanitary and medical aspects of Greek life by the exploration of the shrines of Asklepios, the god of healing, at Epidauros and Athens. Dr. Caton brings together the work that has been done by various archæologists at the sites of these shrines, and contributes to it some observations, restorations and theories of his own. His book contains the substance of two lectures delivered at the Royal Institution, and is well illustrated. The purposes of the various buildings are described or conjectured, and the ritual of the Asklepian shrines, as well as the accommodation and treatment of the sick who frequented them, are considered. A number of large and harmless yellow snakes were kept in the sanctuary, and one of Dr. Caton's original suggestions is that the labyrinth below the beautiful Tholos or Thymele temple may have been the home of these creatures, which were reverenced as the incarnation of the god, and were utilised in the treatment of the patients. We read "The sick were delighted and encouraged when one of these creatures approached them, and were in the habit of feeding them with cakes. The serpents seem to have been trained to lick with their forked tongues any ailing part. The dog also was sacred to Asklepios, and the temple dogs in like manner were trained to lick any injured or painful region of the body." Three centuries before the commencement of the Christian era the rulers of Rome sent a galley to Epidauros to fetch the god Asklepios to check a pestilence. One of the sacred serpents was carried in the galley, and it left the ship as soon as the insula in the Tiber was touched. The plague is said to have disappeared at once, and in gratitude to the god which was believed to be present in the form of a serpent, a temple was erected to Æsculapius, as the Romans designated him, and from that time this island in the Tiber has been devoted to the cure and treatment of the sick. Moreover, adds Dr. Caton, "It is doubtless, in consequence of this episode of the foundation of the temple of Æsculapius on the island of the Tiber, that the staff and serpent of the Epidaurian god have been, and remain to this day, the symbol of the profession of medicine." These remarks are sufficient to show that the book is of real interest in connection with the history of medicine, and merits the consideration of students of classical archæology.

"ONE THOUSAND OBJECTS FOR THE MICROSCOPE, WITH A FEW HINTS ON MOUNTING." By Dr. M. C. Cooke, M.A. (Frederick Warne and Co.) Illustrated. 2s. 6d.—Dr. Cooke's descriptive guide to microscopic objects easily accessible and possessing characteristics worthy of observation has been a helpful friend to many microscopists. In its new form the book should be even more successful, for the introductory part now given contains just the kind of information as to the miscroscope and its essential accessories, and the manipulation, collection and mounting of objects, most needed by everyone taking up microscopy either as a source of mental recreation or as a serious study. It must be borne in mind, however, that the casual examination of a variety of natural objects is of little use unless the observer has a good memory and can bear in mind the specific characteristics of the things he sees. To be of value it is necessary to make notes and to compare the structures and organs of various plants and animals with one another, or to devote attention to one particular organism and find out as much as possible about it.

"IMITATION OR THE MIMETIC FORCE IN NATURE AND HUMAN NATURE." By Richard Steel. (Simpkin.)—This book belongs to a class the virtues of which are best appreciated by the individual authors. A number of similar books have been published and they are all the despair of the reviewer, who desires to do them justice so far as the limitations of time and space will permit. It is, however, practically impossible to describe satisfactorily the argument set forth or to submit the contents to minute criticism. So far as we are able to make out, Mr. Steel aims at the apotheosis of the imitative faculty in organic and inorganic nature. Every biologist knows that mimetic force is an important factor in the organic development, and it would be possible to exemplify its action by many cases. Mr. Steel deals with imitation in animal and vegetable life, but this subject only occupies a small part of his book. In the remaining part he gives reasons for believing that the influence of imitation is very great in other ways, and indirectly affects almost every aspect of bodily, mental and spiritual activity of man; in fact, practically every thing and phenomenon in the realm of natural and abstract philosophy, from the law of gravitation and the use of a silk hat, to the conception of a First Cause, is shown to depend upon the tendency to imitate. To some of the cases stated in support of this thesis no objection need be raised, but others will not so readily meet acceptance, and the want of precision of the whole makes the reading of the book wearisome to people who are used to concise statements of fact.

"RAILWAY RUNS IN THREE CONTINENTS." By J. T. Burton Alexander. (Elliot Stock.) 7s. 6d. net.—Engineers and others connected with railway working will find this volume very handy for reference, as it contains a record of actual performances on some European, Canadian, Australian and American lines, as observed by the author while riding on the engine or in the train. From the times given for each run we see at once how far the time-tables of the various companies are adhered to in actual running, and on which lines time is best kept, or, if lost, regained. Particulars are also given as to the load drawn, and the class of locomotive used. The book is thus one which, while technical in its subject, is worth bearing in mind as containing a compact statement of the relative performances of many celebrated trains in various parts of the world.

"PRIMER OF ASTRONOMY." By Sir Robert Ball, LL.D., F.R.S. Cambridge: University Press. 1s. 6d. net.—It is not very easy to write an elementary text-book in astronomy which will have many points of originality. The most we can expect is that it should be well written, well arranged, and have clear and full explanations of the different departments of the science. Judged by this standard, we have nothing but praise to offer to this little work. It is written with the command of the right word and the right expression that is so characteristic of Sir Robert Ball's style; the arrangement is very fair; and Sir Robert goes deeper and more fully into the various branches, both fundamental and physical, of astronomy than the dimensions of the book would have led one to expect.

"HAND-BOOK OF PRACTICAL BOTANY." By Dr. E. Strasburger. Translated and edited from the German by W. Hillhouse, M.A., F.L.S. Fifth edition. Re-written and enlarged. (Swan Sonnenschein.) Illustrated. 10s. 6d.—A new English edition of Professor Strasburger's well-known "Das Botanische Praktikum" is a welcome addition to botanical literature. Three years ago the author published a third edition of the German work, from which Professor Hillhouse has prepared the volume before us. The author's name is a sufficient guarantee of the excellence of the work, which is designed for the student of microscopy, as well as for those who desire to study the structure of plants from a more distinctly botanical point of view. It has been accessible to English readers since 1886, and few of the numerous treatises on practical botany are better known and more thoroughly appreciated in English laboratories. The directions are given in great detail, and the materials required are not beyond the capabilities of small institutions, and may be obtained without difficulty by the isolated worker.

The fifth edition contains some additional matter and has undergone other changes at the hands of the English editor. The translation is less literal and the English freer and more pleasantly readable than formerly—a change which will be favourably received. The appearance at the head of each chapter of the list of reagents, as well as of the plants required, will be found a great advantage. We think [illegible] regret that the editor has decided to omit th[illegible] which were appended to each chapter [illegible]. Many, perhaps the majority, of those who [illegible] not suffer from the omission, but to others [illegible] to more advanced botanical work the [illegible] considerable value. The important divisions of th[illegible] indicated by italicised headings to the paragraphs, [illegible] reference, the need of which was [illegible] the earlier editions. We have no doubt that [illegible] will quickly be as well represented on the work-benches of botanical institutions as its predecessors have been.

"THE COMPLETE WORKS OF JOHN KEATS." Edited by H. Buxton Forman. In five volumes. (Glasgow: Gowans & Gray.) 1s. each. The fourth volume of this scholarly edition of the works of Keats is now issued, and in welcoming it for the complete character of its text and the elaborate detail of its notes and marginalia, we cannot too highly commend the attempt of the publishers to give the public an edition of the English classics which is irreproachable as to the correctness of its text, altogether admirable in its form and style, and at the same time quite inexpensive. It would be ungracious in the presence of so erudite an editor as Mr. Buxton Forman to raise any objection to the profusion of his notes, but we are strongly of opinion that there is a distinct danger of overlaying the poet by the notes, having regard to the object of a popular edition, as the general reader is so easily dissuaded, and it may become a task instead of a pleasure to extricate your poet from a redundancy of notarial lore. Let the poet speak for himself, and dispense with the chorus as far as possible.

"JOURNAL OF THE SOCIETY OF COMPARATIVE LEGISLATION." (John Murray.) 5s. We have received from Mr. Murray the sixth volume of the new series of this invaluable journal, containing an exhaustive review of the Legislation of the British Empire for 1899; a brief memoir of the late Lord Chief Justice (Lord Russell of Killowen), from the pen of Mr. Joseph Walton, Q.C.; and a preliminary study, by Sir Frederick Pollock, of the history of the Law of Nature. We observe among the notes some interesting excerpts from the "Cape Law Journal" (now the "South African Law Journal") on some of the many novel questions raised in connection with the unhappy war with the two Boer Republics.

"AGRICULTURAL ZOOLOGY." By Dr. J. Ritzema Bos. Translated by J. R. A. Davis. Second edition. (Methuen.) Illustrated. Price 3s. 6d.—The first edition of this excellent little work was published in 1894, and the comparatively early date at which a second has been demanded bears testimony to its usefulness and that it supplies a long-felt want. The present edition, besides a careful revision of the text, differs from its predecessor by the addition of an appendix, which consists mainly of a translation of the introduction to a larger work on the same subject by the author, and likewise a classification of agricultural pests according to habitat. An index is also an all important addition. The work gives a systematic survey of all the groups of the animal kingdom which can be said to affect agriculture in any way, either injuriously or beneficially. And although in certain respects the classification employed is somewhat antiquated, while some of the illustrations might be better, this conspectus has been well carried out, and is written in a style free from unnecessary technicalities, so that it may be understood without much difficulty by the intelligent farmer and gardener. The original German work described, of course, all the animals met with on the Continent which affect agriculture; in the English editions some of the non-British species are printed in small type, and it would have been better, we think, if the same distinction had been applied in all cases, *e.g.*, the corn-mouse (p. 41). It may be added that neither author or translator appears to be aware that the pine-marten (p. 26) is not a British species. Moreover, we must deplore the inclusion of the swift and the swallow in a single family (p. 58), as tending to perpetuate a misconception of affinities. But, after all, the agriculturist is more concerned with invertebrate than with mammalian pests, and we have nothing but commendation to bestow on that portion of the work dealing with insects, "flukes," etc. Indeed the section devoted to the life-changes of the liver fluke and its kindred is excellent and can scarcely fail to arouse the interest of the farmer who has hitherto been acquainted with this malignant pest in a single phase of its chequered career. Seeing, however, that Miss Ormerod, in her introduction, has bestowed unstinted praise to this portion of the work, it would be almost an impertinence on our part to attempt further commendation.

BOOKS RECEIVED.

The Birds of Siberia. By the late Henry Seebohm. (Murray.) Illustrated. 12s. net.

The Romance of the Heavens. By Prof. A. W. Bickerton. (Swan Sonnenschein.) Illustrated. 5s.

Arsenic. By Prof. J. Alfred Wanklyn, M.R.C.S. (Kegan Paul.) 2s. 6d.

The Design and Construction of Oil Engines. By A. H. Goldingham, M.E. (Spon.) Illustrated. 6s. net.

The Elements of Darwinism. By A. J. Ogilvy. (Jarrold.) 2s. 6d.

The Colour Cure. By A. Osborne Eaves. (Wellby.) 1s. 6d. net.

Twentieth Century Inventions: A Forecast. By George Sutherland, M.A. (Longmans.) 4s. 6d. net.

Elementary Practical Mathematics. By M. T. Ormsby. (Spon.) Illustrated. 7s. 6d. net.

Disease in Plants. By H. Marshall Ward, SC.D., F.R.S. (Macmillan.) 7s. 6d.

A Text-Book of Sonography. By John H. A. McIntyre, M.I.M.E. (Blackie.) Illustrated. 3s. 6d.

The Elements of Differential and Integral Calculus. By J. W. A. Young and C. E. Linebarger. (Hirschfeld Bros.) 10s. 6d. net.

The Structure and Inherent Motions of the Universe. By Edward Meyer. (Adelaide: A. & E. Lewis.)

Familiar Wild Birds. Part I. By W. Swaysland. Illustrated by A. Thorburn and others. (Cassell.) 6d.

The Photo-Miniature. Vol. II., No. 24, March 1901. (Dawbarn and Ward.) 6d.

Stonyhurst College Observatory. Results of Meteorological and Magnetical Observations. (Clitheroe: Parkinson and Blacow.)

Whist Dialogues. By Major Jack Tenace. (Bruxelles: E. Wagemans.)

A Natural System of Map Drawing. By Prof. A. W. Bickerton. (Swan Sonnenschein.)

The Scientific Roll: Bacteria. By Alexander Ramsay. (R. L. Sharland.) 1s.

A La Conquête du Ciel! F. C. de Nascius. (Nantes: A. Dugas.)

The Use and Abuse of the Harrogate Mineral Waters. By Arthur Roberts, M.D., M.R.C.S. (Harrogate: Robert Ackrill.) 6d.

Archives of the Roentgen Ray. August, 1900, and January, 1901. (Rebman, Ltd.) 1s. net.

NOTES.

ASTRONOMICAL.—An account of a new astronomical undertaking of great magnitude has recently been given by Professor Auwers. The object is nothing less than to collect into one great catalogue the determinations of the positions of stars which have been made during the last one hundred and fifty years, and to reduce them all to the equinox of 1875. At the present time the observations are distributed through more than three hundred catalogues, and much time is lost in consulting these different sources of information and in correcting the positions for the epoch required. It is estimated that the total number of star places to be dealt with will be about a million, and proper motions will be investigated whenever possible. The work is to be undertaken by the Berlin Academy of Sciences, which received a permanent endowment for it during the bicentenary celebrations last year. Dr. F. Ristenpart has been appointed chief of the computing staff, and the work will be under the general superintendence of a committee of which Professor Auwers is president.

The presence of free hydrogen as a normal constituent of our atmosphere to the extent of about two volumes in ten thousand, has been demonstrated by the experiments of M. Armand Gautier. The result is of great interest in connection with Dr. Johnstone Stoney's views as to the tendency of gases to escape from the atmospheres of planets when their molecular velocities are great enough to overcome the gravitational attraction. On this view the earth cannot retain hydrogen, but there is of course a possibility of its continued production. Professors Liveing and Dewar, who have previously found free hydrogen in air, suggested that there might be a continued accession of hydrogen from interplanetary space.

A suggestion made by Lord Rayleigh in 1893 to the effect that in astronomical photography the plates should be accommodated to the telescopes rather than telescopes to the plates, has recently been acted upon with complete success at the Yerkes Observatory. Photographs taken with the great refractor (which is corrected only for the visual rays) on isochromatic plates, through a suitably-coloured screen, are perfectly defined, and the large scale greatly augments their value for purposes of measurement. Pictures of the star cluster in Hercules and of portions of the moon's surface show a great amount of detail.—A. F.

BOTANICAL.—The force exerted by swelling seeds has been demonstrated by experiments made by Dr. D. T. MacDougal, who has published the results obtained in the March number of the *Journal of the New York Botanical Garden*. It was ascertained by means of a manometer that peas, on being wetted, exerted a pressure sufficient to compress a column of air from a length of 6·30 to ·75 inches, which is equal to eight atmospheres, or 120 pounds to the square inch.

Herr von Minden has a paper in the last published part of *Flora* on the irritability of the style in two species of *Arctotis* (*A. aspera* and *A. calendulacea*), which recalls that exhibited by the column in species of *Stylidium*, and which is doubtless concerned in the function of pollination. It was observed that the style on being touched by a needle, or the body of an insect, immediately became strongly concave on the side touched, so that the stigmas, which had received a coating of pollen on the outside during their passage through the staminal tube, would come in contact with the irritating agent, to which, in the case of an insect, some pollen would be conveyed.

In *Hooker's Icones Plantarum*, Vol. xxvii., Part 4, Mr. Hemsley continues his revision of the genus *Sapium*, to which belongs the tree that produces the Colombian india-rubber of commerce. Eight species are described, five of them being new. The Peruvian *Castilloa australis* is described and figured in the same work. This plant yields caoutchouc, like the well-known *C. elastica*, the chief source of Central American india-rubber.

Das Pflanzenreich is the title of a colossal work which is now being published under the editorship of Dr. Engler, of Berlin. The three parts already issued consist of monographs of the Musaceæ, Typhaceæ, Sparganiaceæ, and Pandanaceæ. The plan of the work, which, it is anticipated, will take twenty years to complete, is somewhat the same as that followed in Engler & Prantl's *Pflanzenfamilien*, but in *Das Pflanzenreich* species, subspecies, and varieties are described as well as orders and genera. The concise descriptions are supplemented by illustrations of the more characteristic species.—S. A. S.

METEOROLOGICAL.—In the present state of knowledge and opinion, the new meteorological journal, *Climat*,* strikes one as rather a bold venture. It explains weather

* Published in St. Petersburg, Nevsky, 88, in four languages. Twice a month. Agents for British Isles: Hugh Rees, Limited, 124, Pall Mall, London, S.W. 16s. per annum.

by the moon, and not only so, but undertakes to supply forecasts of weather some weeks ahead at a host of stations in the northern hemisphere. The editor, M. Demtchinsky, gives a number of cases in which he has successfully foretold Russian weather during the past year, and he now extends his system. In the number before us (1st April, No. 2), we find charts for some seventy-eight places in Europe and North America, showing the probable course of the barometer and thermometer, etc., in the latter half of April: also maps with isobars and isotherms for one date in each week. Such claims, it is obvious, must be soon either justified or discredited, and we shall watch the result with interest. M. Demtchinsky evidently has faith in his system, and we wish him success with it. We regard with favour (personally) the rehabilitation of the moon which seems to be now in progress, but if this Russian engineer's claims can be established, then meteorology has of late made, in Russia, an unwonted leap forward. A complete and unbroken success in these forecasts need not, of course, be looked for, nor does the author expect it; but there might, perhaps, be a practically useful percentage of success. In any case, the question of lunar influence should be somewhat elucidated. Besides these forecasts, the journal will publish various meteorological papers, especially such as bear on the moon's influence. The journal is in four languages, Russian, French, English, and German. We rather doubt the utility of this; in perusing these polyglot serials, one is apt to be reminded of the "halfpenny-worth of bread to an intolerable deal of sack!"—A. B. M.

Zoological.—Much difference of opinion has prevailed among naturalists on the question of the pedigree of the leathery turtle (*Dermochelys coriacea*), some maintaining that it is a descendant from the same stock as ordinary turtles, while others assert that it is of totally different origin. In a paper recently contributed to the *Bulletin* of the Royal Scientific Society of Brussels, Mons. L. Dollo expresses himself in favour of the former view. According to this, the tesselated shell of the leathery turtle has been formed by a breaking up of the solid shield of ordinary turtles.

Perhaps a still more important contribution to phylogeny is afforded by Mr. R. I. Pocock's paper on the Scottish Silurian scorpion, which appears in the March number of the *Quarterly Journal of Microscopical Science*. As the result of an exhaustive study of a beautifully preserved specimen discovered in Lanarkshire in 1885, the author is inclined to countenance the idea that modern scorpions trace their ancestry to primitive Arthropods more or less closely related to the marine king-crabs (*Limulus*) of the Moluccas.

According to Mr. Southwell's Report on Whaling and Sealing during 1900, published in the March number of the *Zoologist*, British whalers are not to be represented in the Greenland seas during the coming season, owing to the scarcity of whales. What has become of the right whale in that ocean is the question of the hour. Whalebone of fair size now stands at the enormous price of £1400 per ton.

Those of our readers interested in the classification and pedigree of mammals should study an important memoir by Mr. B. A. Bensley, in the February issue of the *American Naturalist*. The relation of the marsupials to the placentals is the chief theme; and the author accepts the view that the specialised character of the foot in the former precludes their being the ancestors of the latter. He is, however, indisposed to admit the theory that marsupials are degraded placentals, and prefers to regard both as divergent offshoots from a common "metatherian" stock.

When Pallas in the latter part of the eighteenth century described the little creature we now term the lancelet as a kind of slug, under the name of *Limax lanceolatus*, he little realised the interest and importance attaching to his discovery. Little by little the true affinities of this lowly chordate have been worked out; and we now know that, instead of being represented only by a single species, the lancelets include quite a number of different types, which may be arranged under two generic and several subgeneric groups. According to Mr. A. Willey (*Quart. Journ. Micr. Science*, March, 1901), these may be classified as follows:

Genus I. Branchiostoma; generative structures biserial.
  Subgenus 1. *Branchiostoma.*
  „ 2.—*Dolichorhynchus*
Genus II.—Epigonichthys; generative structures uniserial.
  Subgenus 1.—*Epigonichthys.*
  „ 2. *Paramphioxus.*
  „ 3. *Asymmetron.*

In this table we have ventured to make certain amendments in nomenclature in accordance with modern ideas.

If any of our readers study marine worms they should read an important communication on the nemerteans of the Alaska seas, by Dr. W. R. Coe, published in the *Proceedings* of the Washington Academy of Sciences, as part of the results of the Harriman Expedition to Alaska. Quite a number of new forms are described.

The anatomy of a near relative of that remarkably generalised Arthropod known as *Peripatus* forms the subject of an important paper contributed by Dr. W. F. Purcell to the December issue of the *Annals of the South African Museum*. The form there described is referred to the genus *Opisthopatus*; and the author is of opinion that the African representatives of the group should be assigned to three generic types; two of which are exclusively South African, while the third also occurs in America, and possibly in India.

A late issue of the *Proceedings of the Royal Society*, contains an abstract of Dr. Blanford's memoir on the distribution of vertebrates in India, Ceylon, and Burma. The author comes to the conclusion that the Punjab differs so remarkably in its fauna from the rest of India that it cannot be included in the Oriental region, but must be assigned to the Mediterranean province, which is by some regarded as a region by itself, but by others classed as a subdivision of the Holarctic. To the latter belongs also the Himalayan area above the forests, as does Tibet. India proper, together with Ceylon, is regarded as a single subdivision of the Oriental region, under the title of Cisgangetic, while the Himalayas and Burma form a second subregion, the Transgangetic, which also includes Southern China, Tonquin, Siam, and Cambodia. A third subregion, the Malayan, is indicated in the area treated of by Southern Tenasserim, which agrees but in its vertebrate fauna with the Malay Peninsula.

The British and German Antarctic Expeditions.—With the launch of the "Discovery" at Dundee on March 21st, and that of the "Gauss" at Kiel on April 2nd, the siege of the Antarctic regions may be said to have already begun. Both vessels have been specially designed and constructed, and it is hoped that both will be completed and sent off in July or August for the Antarctic regions. Moreover the two expeditions will co-operate in so far that the scientific work will be carried out on similar methods, and that the Antarctic area will, within practicable limits, be divided up between them. The British Expedition will be commanded by Capt. R. F. Scott, and Professor J. W. Gregory of Melbourne University will be chief of the scientific staff. The other members of the scientific staff already appointed are Dr Koettlitz, surgeon and geologist; Mr. E. A. Wilson, also a surgeon, who combines with a good scientific training considerable artistic power; and Mr. Hodgson, of the Plymouth Biological Station, who will devote himself mainly to the zoological work. Captain Scott will have under him Lieut. A. B. Armitage, R.N.R., who has had three years' experience in Franz Josef Land, Lieut. Royds, R.N., Mr. Reginald Skelton, R.N., and two others not yet appointed. The crew, it is hoped, will consist of bluejackets. The German expedition will be under the charge of Professor von Drygalski, who will have four scientific assistants, a captain, a first officer, two mates, and a crew, making twenty-eight in all. The "Discovery," the sixth ship of her name, is somewhat larger than the "Gauss," having a displacement of 1750 tons as against the 1450 tons of the German ship, and a length of 172 feet as against 151 feet. The "Discovery" will be capable of steaming 8 knots, and the "Gauss" 7 knots, but both ships will use their sails whenever possible for the purpose of saving coal. The ships are extremely strongly built in order to withstand the ice pressure, oak and greenheart being the timbers mainly used. On both ships each officer is to have a separate cabin fitted with every possible appliance to secure comfort and sanitation, and equal care will be taken with the quarters of the crews. The "Discovery" will have cabins for special purposes; laboratories for the biologists on deck; and others for photographic and other purposes below; the mainyard is to be fitted with a block for dredging operations; a special magnetic observatory will be constructed on the upper deck, and no iron will be used within thirty feet of it; she will carry five boats, twenty sledges and twenty dogs, and will be well supplied with every sort of amusement and appliance to make life as pleasant as possible through the long Antarctic night. The "Gauss" is also to be provided with laboratories and other special arrangements for scientific work. As far as possible the use of iron has been avoided in her construction, in the interest of the magnetic observations, and its place is taken by copper whenever feasible, and where this could not be done the iron has been coated with zinc. She will carry a windmill, material for a dwelling house, and four observatories; a captive balloon, fifty dogs, and a naphtha and other boats. Both ships will be fitted with electric light, and will carry provisions for three years.

THE INSECTS OF THE SEA.—III.

By Geo. H. Carpenter, B.Sc.(Lond.), *Assistant in the Museum of Science and Art, Dublin.*

BEETLES.

Beetles are so very numerous, dominant, and widespread in all parts of the world and in all sorts of localities that the presence of a fair number by the tidal margin might reasonably be expected. And although if individuals be counted up, marine beetles will probably be found fewer than marine spring-tails, it is likely that in the number of kinds that occur, beetles outnumber all other insects, except possibly the flies, by the sea-shore, as they seem to do in the world at large.

The general form of a beetle is known even to those who have never studied in detail the structure of insects. The most characteristic feature is the modification of the forewings into firm plates of leathery or horny texture, to serve as shields—"wing-cases" or elytra—for the membranous hindwings—alone used in flight—which can be folded beneath them. Beetles thus form an easily recognised order of insects the "Sheath-wings" or Coleoptera. And the folding up and putting away of the wings beneath their horny sheaths, as practised habitually by beetles generally, is suggestive of the fact that many beetles have entirely lost the power of flight. As a group the beetles have largely forsaken an aerial for a terrestrial life. Their armour-like coats, and the frequently flattened form in very many of the families, correspond with a life on the ground beneath stones, and in such concealed lurking places. Consequently adaptation to tidal conditions is less difficult to beetles than to typically aerial insects, and hence the large number of marine representatives of the order. Among the spring-tails we found that several large genera have each several species adapted for life on the sea-shore. The same state of things occurs among the beetles, but here the adaptation has proceeded further, since we shall find not species only but genera entirely confined to the tidal margin. A high degree of specialization for marine life has, therefore, been reached by many beetles.

It is well known that beetles undergo a "complete" transformation, the young insect being hatched from the egg as a grub or larva—wingless, and more or less unlike its parent, and attaining the perfect state only after passing through a period of rest as a pupa, in which the form of the organs of the future beetle can be clearly made out. There are many interesting steps in the progress towards a truly marine life that can be studied among the beetles. In the great family of the Leaf-beetles (Chrysomelidæ), there is a genus (Donacia) whose species, found on freshwater plants, spend most of their time entirely submerged. Their grubs live at the bottom of the water, feeding on the roots of aquatic plants, and they are provided with two spines on the eighth abdominal segment, by means of which they pierce the roots and breathe from the air-spaces enclosed therein.* An allied genus, Haemonia, has a species *H. Curtisii*, Lac., found in brackish water on that characteristic marine plant the grass-wrack (Zostera). A similar progress towards life in the sea can be traced in other groups of water-beetles. The Gyrinidæ or "Whirligig" beetles, whose quick mazy dance on the surface of ponds and streams is well known, have a species (*Gyrinus marinus*, Gyll.) which is usually found in brackish water, though it also occurs in inland, freshwater localities. Among the aquatic beetles of the family Hydrophilidæ—characterised by the unusual length of the palps or jaw-feet of their first maxillæ, and their remarkably short feelers, the genus Ochthebius has several species, which frequent brackish ponds and ditches near the coast, and others which haunt stagnant rock-pools that are, at least during the high spring-tides, washed out by the rising sea.

Many of these Hydrophilidæ are not truly aquatic in their habits, but live in marshy places and damp decaying matter. To this section belongs the genus Cercyon, which has two species (*C. littoralis*, Gyll., and *C. depressus*, Steph.) inhabiting the sea-coast, and often

* L. C. Miall, "The Natural History of Aquatic Insects," London, 1895 (pp. 93-96).

occurring below high-water mark. These have invaded the tidal area not from the freshwaters, but from the land. Most sea-shore beetles, indeed, are incursors from the land. Many beetles of various families abound in salt-marshes and on coast sand-dunes; certain kinds can be traced down to high-water mark, whilst the most characteristic beetles of the sea dwell between tide-marks and undergo immersion twice every day.

In temperate countries at least, the Rove-beetles (Staphylinidæ) form the most numerous family of the order, and on the sea-shore they maintain this predominance. The form of these beetles is generally known. They are usually narrow, elongate insects, with very short wing-cases, beneath which the membranous hind-wings are nevertheless completely folded up and hidden when at rest. The hind-body, not as in most beetles, covered by the wing-cases, but projecting far beyond them, has all its seven segments firm-skinned and freely movable, so that this part of the insect can be turned about at pleasure; a number of Rove-beetles carry it turned upwards, as a scorpion carries its tail. Most of the Rove-beetles prey upon insects smaller or weaker than themselves.

Many salt-marsh and sand-haunting Rove-beetles belong to the large genus Bledius, which, with some allies, differs from most genera of the family by the feet having only three (instead of five) segments. The Bledii dig burrows in the sand or mud, and the material they throw up forms little heaps or castings. Several species live on sandy sea-coasts. The habits of *B. fuscipes*, Rye, were observed with some care years ago by Mr. K. Taylor; these insects seem to live amicably in pairs. At the bottom of a vertical burrow about an inch and a half deep, one individual—presumably the female—was found, while her mate mounted guard in a short horizontal tunnel opening out from the burrow near the surface of the sand.

Nearly allied to the Bledii, and of somewhat similar habits, are the smaller, more hairy and less spiny beetles of the genus Trogophloeus. These are often found in marshy places by the banks of streams. A new marine species, *T. anglicanus*, which has lately been described by Dr. Sharp from specimens discovered near Plymouth, is of uncommon interest, since it seems to be almost identical with a beetle (*T. unicolor*, Fauvel) of similar habits that lives on the coast of New Zealand. M. Fauvel, indeed, does not consider that the slight structural differences warrant specific separation. In his record of the discovery, Dr. Sharp† discusses the problem of this strange similarity, and considers that the only alternative to the highly unlikely suggestion that the insect has been brought by ships from the other side of the world, is that closely similar species have been independently developed here and at the Antipodes, under similar conditions of life. The possibility of a multiple origin for the same kind of animal in different localities can hardly be denied, since it is certain that the same variety can be thus independently produced under similar conditions, and what is a variety but a species in process of being made.

Quite a number of Rove-beetles may be found running among the decaying seaweed that is cast up by the high tides. Several of the large and widely-spread genera of these insects have each two or three species living in this way. The genus Aleochara for example (characterised by the presence of an extra tiny segment on each palp or jaw-foot) h[illegible] s[illegible]d-hauntin[illegible] species widely distributed a[illegible] These are characterised by their dull [illegible] having a thick whitish hairy clothing. S[illegible] is very often found on marine insect[illegible] evident, as it serves to retain a layer of air [illegible] when they undergo immersion. Even when [illegible] water they are not really wetted.

Similarly the large allied genus of Hom[illegible] has a small group of marine species. In their general aspect, the pale hairy clothing, the relatively short feelers, and the parallel sides of the hind-body, these Homalotæ are remarkably like the Aleocharæ just mentioned. By some authorities, therefore, the two groups of beetles are believed to be closely allied. But the minute structural differences between them—the number of segments of the palps and of the fore-feet for example—seem to show that their likeness to each other is the result of a convergence under similar conditions of life.‡

Belonging to the same group of the Rove-beetles as the Homalotæ are some small insects belonging to the genus Myrmecopora (or Xenusa), altogether adapted to a sea-shore life, only being found close to the water's edge, and often occurring between tide-marks. Two kinds—*M. uvida*, Er., and *M. sulcata*, Kies., inhabit our shores. These little insects may be seen either running briskly among the seaweed and on the rocks and shingle, or flying quickly in the sunshine. Sometimes they may be observed to alight on the water of a rock-pool, then, their expanded wings serving as sails, they are easily blown along on the surface-film.

Both the Aleocharæ and the Homalotæ are small insects—only about 3 mm. (⅛ inch) in length. There are, however, some more imposing Rove-beetles found among seaweed, measuring from 5 to 12 mm. (⅕ to ½ inch). These are the species of Cafius, all of which seem to inhabit the sea-shore, or at least the margins of tidal rivers; they are nearly related to the beetles of the large and dominant genus Philonthus. We have four species on the British coasts—*C. cicatricosus*, Er., *C. fucicola*, Curtis (Fig. 3), *C. xantholoma*, Grav., and *C. sericeus*, Holme. The first of these [illegible] confined to the south coast; all the others are widespread, but only *C. xantholoma* can be considered common. *C. sericeus* is the only species of Cafius which [illegible] the woolly covering usually characteristic of marine insects. As one turns

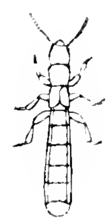


FIG. 1.

FIG. 2.

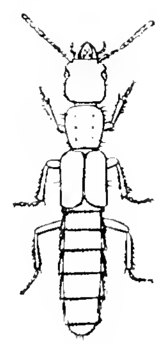


FIG. [illegible]

FIG. 1.—*Aleochara Rendiaqu[illegible]*, magnified 15 [illegible]

FIG. 2.—Grub of *Cafius*, magnified 4 times.

FIG. 3.—*Cafius fucicola*, magnified 4 times.

† D. Sharp. "Some undescribed Species of *Trogophloeus*." *Ent. Mo. Mag.* XXXVI. 1900, pp. 230-4.

‡ W. W. Fowler, "[illegible] of the British Islands," London, 1887-91. L. Ganglbauer, "Die Käfer von Mitteleuropas," Wien 1892, etc.

over the damp seawrack, one sees these beetles darting rapidly about; sometimes they burrow into holes in the sand. Deeper search among the heaps of seaweed may reveal their grubs (Fig. 2), which are narrow and pointed towards the tail end, the head as in the perfect insect is large and powerful, the legs strong and spiny, and the body rather strongly armoured. Both beetles and grubs appear to prey on the maggots which feed on the decaying vegetable matter found so abundantly in these seaweed heaps.

A little assemblage of Rove-beetles, to be looked for almost exclusively below high-water mark, are especially interesting. Actocharis is a genus of only one species—*A. Readingii*, Sharp—found on our coasts only in Cornwall and Devon, but occurring also on the French and Sicilian shores. This rare beetle is very small, only 1.5 mm. (about $\frac{1}{16}$ inch) long and of remarkably narrow form, even for this family (Fig. 1). This fragile little insect, covered with a dense silky pubescence, and with its unarmed legs very broad and flat, offers a strong contrast to the powerful and spiny Cafius. Some of its characters—such as the incomplete fusion of the pair of jaws (second maxillae) forming the "lower lip"—mark it as a very ancient type.

The species of Phytosus are not quite so small as Actocharis. Their shape is characteristic, the hind-body widening towards the tail-end, and the feelers being relatively very short. Three kinds—*P. spinifer*, Curtis, *P. balticus*, Kraatz (Fig. 5), and *P. nigriventris*, Chev., inhabit our coasts; these little beetles fly in the sunshine. The first-named is often found running on rocks or shingle, while the two latter usually prefer to lurk under seaweed or refuse; a dead starfish often serves both as shelter and food for a large colony. These beetles occur all along the coasts of western Europe and north-western Africa; other kinds inhabit the shores of North America, and the genus reappears far away in the southern seas on the Falkland Islands and Kerguelen. Long considered as exclusively maritime, Phytosus (*P. balticus*) has lately been discovered almost in the centre of Ireland—that country of ancient survivals—on an islet in the freshwater reaches of the middle Shannon.

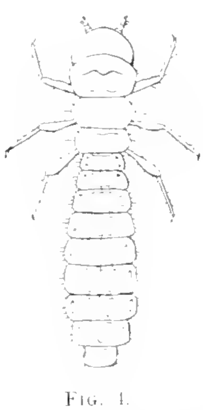


Fig. 4.

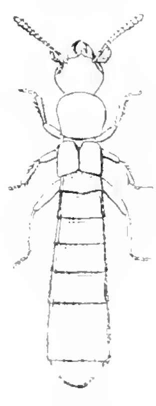


Fig. 5.

Fig. 4.—Grub of *Phytosus nigriventris*. (After Fauvel.) Magnified 24 times.

Fig. 5.—*Phytosus balticus*. Magnified 24 times.

The grub of *Phytosus nigriventris* has been described by Fauvel.§ It is remarkable in being very like its parent-beetle in shape, narrowed at the base of the hind-body and broadened towards the tail-end (Fig. 4). Such a likeness between perfect insect and grub is clearly a sign of antiquity, for the most highly-organised insects are the most unlike the larvæ whence they develop. The active, highly organized blowfly, for example, stands in the most extreme contrast to its sluggish degraded maggot.

§ A. Fauvel. "Notice sur quelques Aléochariens et description de Larves de Phytosus et Leptusa." *Ann. Soc. Ent. France* (4), II., 1862, pp. 82-94 pl. II.

(To be continued.)

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

Notes on the Singing of a Song Thrush. On the 24th of March, at 5.30 a.m., a thrush commenced its morning song in a garden at Stroud, where I was staying, and continued, with pauses of the usual brevity till 7 o'clock, when it was silent for rather more than two minutes by my watch; after which it sang till 8.15. It was not in the garden later in the day till 4 o'clock, when it began its evening song. This I did not time; but I feel sure that it exceeded two hours altogether. The musical range of pitch did not often exceed $3\frac{1}{2}$ tones, say, from C up to G. But sometimes an additional higher or lower note was given, so that the full range might have been an octave. Probably the bird sang elsewhere during the day, for in 1885 I timed a thrush (a very exceptional singer) for 16 hours in one day. The chief point of interest in such performances is not mere duration of song, but the great variety of the component sounds. In the present instance I counted thirty different strains or kinds of songs in the space of a quarter of an hour; and the first two dozen of these were given almost in succession. The last few, however, were heard at intervals in the reiteration of the commoner strains. From long familiarity with the subject, I made the record with some confidence. One cannot affirm that all these songs or strains were deliberately modulated; yet, when one remembers how much easier it would be for a thrush to repeat one strain time after time, as do the inferior songsters, it is apparent that this pleasing diversity must be intended. And different thrushes attempt it with unequal success. There is no positive proof that the thrush studies and deliberates in his singing, but the circumstantial evidence to that effect is strong, suggesting that the bird has a much higher plane of purpose and method than the mere prolongation of singing implies. It is remarkable that until the last few years the mimicry of the wild song thrush was never observed, or at least, never recorded. Yet some thrushes mimic almost as distinctly as starlings; and there are few pleasanter pastimes in warm weather than to rest under a tree in which a thrush is singing, and to notice his varying success in efforts to reproduce some well-known cries of other common birds.—CHARLES A. WITCHELL, Cheltenham.

Nutcracker in Sussex (*Zoologist*, March, 1901, p. 107).—Mr. H. Marmaduke Langdale records that a Nutcracker was shot on December 21st, 1900 at Chilgrove, near Chichester. This bird was probably a straggler from the invasion of the eastern form of the Nutcracker into Scandinavia, Germany and Holland (*see* KNOWLEDGE, November, 1900, p. 256).

Hairy-plumaged Moorhens (*Zoologist*, March, 1901).—Mr. H. E. Forrest has, during the last three years, examined five specimens of a singular variety of the Moorhen taken at various places near Shrewsbury. These birds were light yellowish-brown on the upper parts, and very light grey underneath. The feathers, "instead of having the pinnæ united into a compact web, have them all separate, especially on the exposed portion of each feather." The defect extends to the flight feathers, so that the birds could not fly, yet they seemed healthy. By a microscopic examination, Mr. Forrest found that "the barbs and hooklets which, in ordinary feathers, cause the pinnæ to cling together in a compact web, are almost entirely absent on the body-feathers; whilst in the quill feathers many of the pinnæ have barbs on one side, but no hooklets to hold them together."

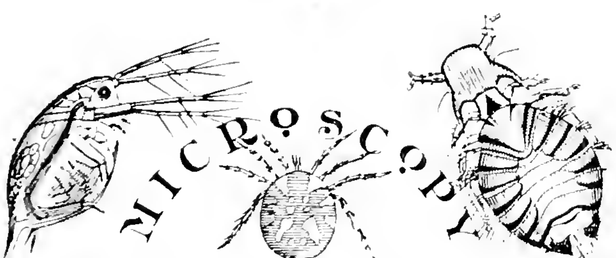
Black-tailed Godwit in Co. Wexford (*Irish Naturalist*, April, 1891, p. 93).—Mr. G. E. H. Barrett-Hamilton records that Black-tailed Godwits were very plentiful at Kilmore, in Co. Wexford, during December and January last. This bird is an irregular visitor to Ireland at any time, while in winter it has but rarely been observed.

Honey Buzzard in Solway (*Annals of Scott. Nat. Hist.*, April, 1901, p. 80).—In an article entitled "Zoological Notes from Solway," Mr. Robert Service describes how his friend, Mr. Jardine, found a Honey Buzzard on January 17th last. His collie dog "set" by a sheep trough, and a large "Hawk" got up and flew some forty yards. Mr. Jardine followed, and with no difficulty caught the bird. It was liberated in a barn, and there Mr. Service saw it, and pronounced it to be a "particularly fine Honey Buzzard in the most splendid condition." The bird had no signs of escape from captivity and no wounds, yet it was strangely tame, and allowed itself to be stroked. The appearance of a dog, however, caused its whole aspect to change "to a fierce and fighting attitude." The Honey Buzzard is a great rarity in Solway.

Barred Warbler in Barra (*Annals of Scott. Nat. Hist.*, April, 1901, p. 114).—On October 29th, 1900, Mr. W. L. MacGillivray shot a young Barred Warbler in Barra. This is but the third Scottish example, and curiously enough all have been obtained in the western isles.

Scops Owl in Shetland (*Annals of Scottish Nat. Hist.*, April, 1901, p. 116).—In KNOWLEDGE for August, 1900, p. 181, a bird of this species was noted to have been captured for the first time in Shetland. Mr. Clarke now records that a second specimen was obtained in the western part of the main island about the same time as the first.

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.



Conducted by M. I. Cross.

ILLUMINATION WITH ARTIFICIAL LIGHT.—The lamp that has proved most universally satisfactory is the regular one sold for microscopical work, with a ½-inch or ¾-inch wick, but to many people this is objectionable for several reasons, the chief of which is that with the general use of gas and electric light, a mineral oil is not kept in the house, excepting for this special lamp; it also is not clean to handle, and requires a certain amount of attention; also it is not always immediately ready for service when required. In laboratories such a lamp is out of the question, and [illegible] gas jets with upright chimneys, are generally to[o] [illegible].

I have recently been making some experiments with gas and electric lamps to see if some other form of illuminant, always available for use without special preparation, cannot be devised for critical microscopical work.

Two important considerations have to be kept in view, one is that the light must be brilliant, and the other is that it should be possible to focus an image of the source of light by means of the substage condenser, in the field of view.

A very serviceable illumination can be secured with the Welsbach incandescent gas light, but the reticulations of the mantle are an obvious objection, and the flame has too large a surface. These can be overcome by means of a shade of metal surrounding the chimney at a distance of three or four inches. In this shade a small rectangular or circular slot should be perforated. When working, this slot would be treated as the source of light and focussed accordingly.

At a recent meeting of the Royal Microscopical Society, Mr. Rousselet exhibited an incandescent electric lamp of the Edison and Swan "Focus" type, which has a somewhat coarse filament not unlike a corkscrew suspended horizontally in the bulb. This lamp gives an intensely brilliant light, and it has on many occasions been used for magic lantern purposes. It was recommended that the light for microscopical work should be taken from the edge of the filament and focussed in the same manner as the wick of an oil lamp. The light arranged in this way was, however, to my mind too much diffused, notwithstanding that a shade was used. On making further inquiry I find that a stand for an electric lamp is made for laryngological and aural examinations which has joints and movements for adjusting in any desired position. In the usual type it carries an ordinary eight or sixteen candle-power lamp, but it will quite well carry the "Focus" pattern. If now an enclosing shade be provided similar to that described for the Welsbach light above, with an aperture which can be treated as the source of illumination, an ideal electric light for microscopy is secured. This would answer well also for photo micrography.

A lamp, somewhat similar to the foregoing, has been used by me with considerable satisfaction, though long usage has created a distinct prejudice in favour of the ½ inch wick oil lamp.

All workers have not electric current available so this will not appeal to them, but the majority have gas, and where oil lamps are objected to, I would advise a trial of the Welsbach light arranged as described above.

PHOTO MICROGRAPHY WITH ARC LAMP.—Trouble is invariably experienced in maintaining the light in one central position, and several devices have been resorted to in order to control this. No automatic lamp is really useful for the purpose, a hand-fed lamp must be employed. When this is properly adjusted and the condensing lens is in position, a luminous disc will be seen upon the leaves of the partially closed Iris diaphragm of the substage condenser. During an exposure it will only be necessary to maintain this disc in a fixed position by turning the milled head of the lamp very gently as required, and the light may be kept perfectly central for any length of time. It is presumed that a horizontal camera would be used.

STAINING FLAGELLA.—The preparation of Bacteria so as to exhibit flagella has always seemed to be unsatisfactory and difficult. Very few workers are really successful and none have produced permanent mounts. An interesting note occurs in the Thompson Yates Laboratories Report, by Dr. MacConkey, which deserves consideration.

It has been considered essential when staining such preparations to use a mordant, presumably to fix the dye in the substance of the flagellum. It is suggested that the rendering visible of the flagella in consequence of the use of the mordant is not because of the effect which it has hitherto been credited with producing, so much as by causing the flagellum to swell and become thicker. The flagella are of exquisite tenuity, so much so, that when stained, the dyes do not seem to render them visible to the same extent as when a so called mordant is used. The suggestion put forward is confirmed by the statement that the flagella appear to be thicker than they are supposed to be actually, and the organisms themselves are larger after the use of a mordant than when stained in the ordinary way.

There are dyes which have the effect of staining the flagella deeply and producing a thickening, but it is observed that, as these colours fade, the flagella become increasingly fine until at last they are no longer visible.

This is a subject in which, to the ordinary microscopist, few opportunities are afforded of making experiments, but a good service would be rendered if some really definite and permanent process, based on an understood system, could be formulated.

THE ROYAL MICROSCOPICAL SOCIETY.—This Society is well known by name to microscopists in all parts of the world, but comparatively few are aware of the advantages that are associated with the Fellowship of the Society. It has ever been the foremost to recognise and to encourage progress and improvements in matters microscopical, and in consequence of the efforts of the various members, that progress and those improvements have been in many instances directly attributable to the Society's work.

The advantages directly derived by a Fellow of this Society are:—

- He is supplied with a journal bi-monthly, published at 6s. per number, which is the most exhaustive publication on microscopical technique that is issued.
- The rooms of the Society, together with a very fine library, cabinets of beautiful objects, and microscopes for making examinations, are open and available for use throughout the year with a short interval only in the middle of August.
- The meetings of the Society are held at 20, Hanover Square, on the third Wednesday in each month, upon which occasion exhibitions of specimens and new apparatus are made, papers are read, and opportunities afforded for conversing with experts on various subjects.

The inclusive subscription per annum is £2 2s., but those living permanently abroad are entitled to become Fellows and receive the journals for a subscription of 31s. 6d. per annum.

The Secretary would be glad to give further information concerning this Society, and a ticket for admission to any of the meetings, on application to him at the Society's Rooms, 20, Hanover Square, W.

NOTES AND QUERIES.

W. E., Crewe.—The question naturally arises whether the microscope you require is to be used exclusively for petrological work, or do you wish it to be available for ordinary observations. If the former, the "Dick" microscope, by Messrs. Swift & Sons, is exceedingly efficient and comprehensive; if the latter, Messrs. R. & J. Beck, and W. Watson & Sons, offer some well-designed models. Of Continental manufacturers, R. Feuss, of Steglitz, is the one man whose petrological instruments have distinct advantages. It would be advisable for you to get catalogues from these different people, and ascertain by that means what features appeared to be of special importance for your work, and if then I could give you any further advice or assistance I would gladly do so.

The Rev. G. C. J.—Your trouble arises from using cedar-wood oil for clearing; you will find the following procedure answer well: Dehydrate in absolute alcohol, clear in chloroform, and transfer to paraffin.

W. H. C.—No further discussion has taken place on the Abbe diffraction theory, so far as I am aware. Diatoms can be found almost everywhere; the smallest ditch or pool, provided the water is not stagnant, will yield material. The specimen of which you send a sketch is probably a form of Navicula, but it is impossible to tell without actually examining the specimen. You are eligible for membership of the Quekett Club, and either the secretary, or the optical house from which you obtained your microscope, would put you in the way of being nominated.

Mr. Cooper Webb, F.C.S., has sent me a photo-micrograph of the Cat Louse—*Trichodectes subrostratus.* He states that this was "discovered by Mr. Parkes on some English cats at Eastbourne in February last, and may be of interest to some of the entomological readers of KNOWLEDGE, for according to such eminent authorities as Denny, Andrew Murray, and, I think, Burmeister, this parasite had not hitherto been discovered in the country." If any microscopists are interested in the above, I shall be pleased to put them in communication with my correspondent.

J. C. Webb.—I am communicating your offer to the society referred to.

W. P. Hamilton.—I am very much obliged for the red rain dust, and will mount some and give the result in next month's number.

R. H. M.—"Could you kindly inform me whether there is any book published that treats fully on the microscopical anatomy of insects, as I am anxious to take up that particular branch of research?" Can any reader offer a suggestion?

D. M.—"I have for some time made a special study of Desmidiaceæ, especially Closterium, and should be glad to know of some book which treated of the life-history of Desmidiaceæ. In particular I am anxious to discover the cause for swarms of Closterium, which in spring time come up from the mud to the surface of the water, quantities of ten to twenty being connected by a thin mucous filament."

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office,* 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

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

THE frequency with which periodical comets escape detection is perhaps not a little remarkable. Recently the comets of Finlay, Barnard (1884), E. Swift (1894 IV.), and Brorsen have been sought for in vain. It is true that the conditions vary greatly at different returns, and are not often really favourable to the detection of these bodies. And in regard to those comets which have only been observed at a single apparition the positions are seldom accurately known. The visibility of these objects is also subject to considerable fluctuations, due to some inherent physical causes which are not well understood and cannot be sufficiently allowed for. Holmes's comet, which was, fortunately, detected at its first periodical return in 1899, was exceedingly faint then, though its conspicuous appearance in the autumn of 1892 justified the inference that it would be pretty bright. The failure in re-detecting some of these interesting bodies is to be regretted, since it is most desirable to obtain observations at multiple returns in order to determine the orbit elements with accuracy. Certain comets are only visible at alternate returns, others at one out of several returns. The numerous failures to pick up these objects cannot be ascribed to negligence on the part of those having the command of large instruments, for the latter have often been successfully employed in work of this kind. Perhaps the effort has not always been adequate to the occasion, and it is to be hoped that some more systematic method will be adopted in future. If combined action were arranged between the possessors of really powerful telescopes every expected comet might be effectively looked for, whereas under present circumstances some comets receive a good deal of attention, while others have very little, and are enabled to elude recovery.

The list of periodical comets is now very large, and increasingly so. But many of this class of bodies still remain undetected, and in proof of this Giacobini's discovery, in December last, of a comet belonging to the Jovian family may be cited.

DENNING'S COMET (1894 I.).—The return of this object is expected during the ensuing summer, but under circumstances which render it probable that it will escape detection. Herr P. V. Neugebauer gives the following sweeping ephemeris (Ast. Nach. 3700):—

	I. P.P. May 9.		II. P.P. May 25.		III. P.P. June 10.	
	α	δ	α	δ	α	δ
Date.	°	°	°	°	°	°
April 7 ...	60·6	+ 21·7	53·9	+ 19·4	48·4	+ 16·7
„ 23 ...	75·8	+ 24·8	67·6	+ 22·7	60·6	+ 20·7
May 9 ...	93·0	+ 26·2	83·4	+ 25·0	74·8	+ 23·5
„ 25 ...	111·2	+ 25·6	100·6	+ 25·6	91·0	+ 25·0
June 10 ...	129·0	+ 22·7	118·1	+ 24·1	108·3	+ 24·7
„ 26	145·3	+ 18·2	135·6	+ 20·6	125·7	+ 22·4

At the return of this comet in 1894, 295 observations were made, and it was last seen on June 5th in the 30-inch refractor at Nice, when its distance from the earth was about 138 millions of miles.

FIREBALL OF JANUARY 15, 1901.—At 10h. 35m. a meteor sufficiently bright to illuminate the sky was observed by the Rev. S. J. Johnson, of Bridport. Its course began mid-way between α and 45 Cancri, and ended after a duration of 7 seconds right across Castor. At first white, it finally dispersed in a stream of red sparks. The meteor was also seen at Beaminster, Dorset, where "its illumination resembled moonlight for about 10 seconds, when it appeared to split into fragments and disappear in a brilliant shower." It was also seen at Highbury, N., by Mr. Jewell, who describes it as of exceptional size and brilliancy. The meteor was directed from a radiant at 149°—12°, and fell from 61 to 52 miles over the English Channel, disappearing [illegible] miles S.E. of Portland Bill. Path about [illegible] miles and velocity about [illegible] miles per second, according to Mr. Johnson's estimate of the duration. The fireball of 1886, Jan. 11, [illegible] at 158° [illegible] 8° [illegible] probably belonged to the same stream of [illegible] Hydrids as that of the recent meteor, but there seems to have been a wide difference in their velocities, for that of the former object was computed by Prof. Herschel as [illegible] miles per second.

Fireball of January 28. At about [illegible]h. 22m. Mr. Robert Service, at Dumfries, noticed the flash of a fine meteor quite as bright as the half moon, and perhaps a third less in apparent magnitude. In colour it shone precisely like an unshaded electric light, and took about 1½ seconds to pass from about 330° + 80° to 300° + 51°. It went out suddenly with an explosion, showing red and blue sparks. Just three minutes later he heard "with great distinctness in the perfectly still air a sort of double detonation from the direction of low down in the N.N.W., followed by a short thundery rumble, but something in the sound was altogether unlike distant thunder." The meteor was observed by Mr. T. W. Backhouse at Sunderland, who noted the time as 8h. 18m., and describes the object as being one of the most magnificent he had ever seen. It disappeared from view at 342° + 28½°, then passing behind a house. Its flight of about 15° was directed from the point 103° + 54°. The meteor exhibited a variety of colours, the chief being orange towards the last, and then for the last 3° or 4° sea-green, at last a very vivid green; while the bright sparkling tapering train of 4° or 5° was orange. It was also seen by several persons at Edinburgh. The radiant was at about 103° + 52° in the Lynx, and the meteor descended from 76 to 16 miles above Lanark to Strathaven. Path about 61 miles, and velocity 18 miles per second. This brilliant object was directed from the Lyncid radiant, G.C. No. LXXXIV. 103.4° + 50.8°, which seems to be visible during the greater part of the year.

THE FACE OF THE SKY FOR MAY.

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

The Sun.—On the 1st the sun rises at 4.34, and sets at 7.20; on the 31st he rises at 3.52, and sets at 8.2. There will be a total eclipse on the 18th, but it will not be visible in this country even as a partial one; the belt of totality extends from Mauritius, through Sumatra, Borneo, Celebes, and New Guinea. Authorities now consider that the minimum of sunspots has probably been reached.

The Moon.—The moon will be full on the 3rd at 6.19 p.m., will enter last quarter on the 11th at 2.38 p.m., will be new on the 18th at 5.38 a.m., and will enter first quarter on the 25th at 5.40 a.m. The following are the principal 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.
May 8	21 Sagittarii	4.9	12.39 a.m.	62	86	1.51	291	305	19 [illegible]
" 9	d "	4.9	12.26 a.m.	122	153	1.23	222	247	20 [illegible]
" 31	B.A.C. 5109	5.4	11.40 p.m.	44	34	12.56	336	319	13 19

There will be a penumbral eclipse of the moon, partly visible at Greenwich, on the evening of the 3rd. The first contact with the penumbra is at 4h. 6.3m., the middle of eclipse at 6h. 30.7m., and the last contact with the penumbra at 8h. 55.1m. At Greenwich the moon rises at 7h. 28m.

The Planets.—Mercury is in superior conjunction with the sun on the 14th, and will afterwards be an evening star, but too near the sun for easy observation.

Venus is in superior conjunction with the sun on the 1st, and may therefore be considered not observable.

Mars remains in Leo, and will be in quadrature on the 20th. On the 1st he sets about 2.40 a.m., and on the 31st about 12.56 a.m. During the month his apparent diameter ranges from 9.0 to 7.2. On the 15th the illuminated part of the disc will be 0.895.

Jupiter is still in S[illegible] on the 1st about 12.22 a.m., and on the 31st a[illegible]. His path is a westerly one, a little to the [illegible] Sagittarii. The apparent diameter on the 15th [illegible]

Saturn is also in Sagittarius, [illegible] the 1st about 12.35 a.m., and on the 31st about [illegible]. On the 5th he will be 3° 18′ to the east of Jupiter. The apparent diameter of the planet on the 25th will be 16.6, and the major and minor axes of the outer ring respectively 41.5 and 17.1; the ring is thus widely open, and the northern surface is presented to us.

Uranus is in the most southerly part of Ophiuchus, to the west of ξ and ζ, making a nearly equilateral triangle with those two stars. He rises on the 1st about 10.30 p.m., and on the 31st about 8.27 p.m.

Neptune can now only be observed for a short time in the early evening, as he sets about 11.47 p.m. on the 1st, and about 9.22 p.m. on the 31st. He remains in Taurus, nearly midway between 132 Tauri and χ^1 Orionis.

The Stars.—About 10 p.m., at the middle of the month, Ursa Major will be nearly overhead; Cygnus in the north-east; Vega pretty high up in the east; Arcturus a little east of south; Scorpio rising in the south-east; Spica Virginis in the south; 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.

(P. G. L. F.)

No. 1.

1. Q to R6, and mates next move.

No. 2.

Key-move.—1. B to K8.

If 1. . . B moves, 2. B to K3ch, etc.
1. . . Kt to B4, 2. Kt × KtPch, etc.
1. . . Kt × P, 2. Kt to K2ch, etc.
1. . . P to Kt4, 2. R to B5ch, etc.

Correct Solutions of both problems received from J. Baddeley, S. G. Luckcock, C. C. Massey, W. H. S. M., A. H. Machell Cox, Endirby, A. C. Challenger, W. de P. Crousaz, W. Nash, A. J. Head, G. A. Forde (Capt.), Alpha, G. W. Middleton, H. Le Jeune, F. J. Lea, F. A. Wilcock, J. T. Blakemore, G. Groom, H. Boyes, J. Sowden, W. Jay, J. M. K., G. W., Vivien H. Macmeikan, C. C. Pennington, A. E. Whitehouse, C. Johnston, Eugene Henry, J. E. Broadbent, J. A. Nicholson, E. Hunt, F. Dennis, C. Child, C. F. P.

Of No. 1 only from S. Jackson, A. Deal, H. W. Elenm, W. Clugston. The two former give 1. B to Q7 for No. 2; this appears to be met by 1. . . Kt to B4.

Mr. Elenm claims a solution in two moves by 1. B × Kt. Black, however, can pin the Knight by 1. . . B to Bsq.

S. W. Billings.—The Cheltenham post-mark on your card is unfortunately 10.45 [illegible] April 11th. Your solutions, though correct, [illegible] therefore count in the competition.

Col. Bell.—Many thanks for the information of which, as you will see below, I have availed myself.

W. Clugston.—Thanks for the problem. It is marked for insertion in the August number, the programme till that month being already complete. The solver you mention is well known; he competed, if I remember rightly, in a solution tourney in KNOWLEDGE some eight or nine years ago.

J. Baddeley.—I can only repeat that I know no other way of getting any decisive result from a competition limited to problems in two and three moves.

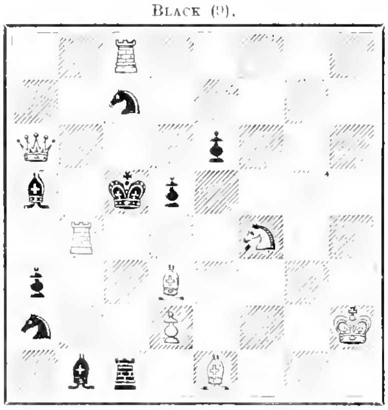
C. C. Massey.—Your deduction from the words "may possibly" is incorrect. The words show that problems of the nature alluded to were originally contemplated, but that, owing to their apparent unpopularity, they would, if given at all, be reserved for emergencies. You will see that, in your other reference, you have confused "problems known to have *no* solution" with "problems known to have more than one solution." The former class is certainly illegitimate, the statement "White mates in, etc.," being clearly of the nature of a falsehood.

PROBLEMS.

By Mrs. W. J. Baird.

No. 1.

BLACK (9).

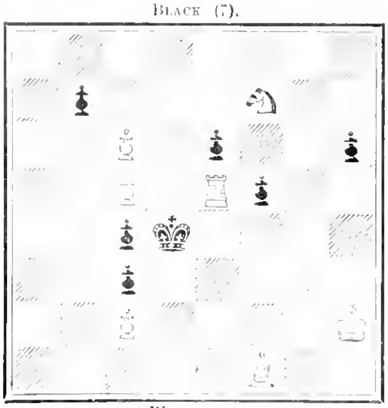


WHITE (8).

White mates in two moves.

No. 2.

BLACK (7).



WHITE (9).

White mates in three moves.

CHESS INTELLIGENCE.

The Anglo-American Cable Match will have taken place before this page appears. The British team will be weakened by the absence of Mr. Blackburne, who, so far as I know, has assigned no reason for his abstention. Fortunately it has been discovered that Mr. Mason is eligible, and he will probably be invited to take Mr. Blackburne's place. Mr. Burn is again not playing, and Mr. E. O. Jones will probably play instead of Mr. Trenchard, who has been out of form lately.

Herr C. Schlechter has again given evidence of consistent form by his victory in the Vienna Club Tournament with a score of 9 out of 11. Herr Alapin was second with 8, and Herren Albin and Marco divided the third and fourth prizes with scores of $6\frac{1}{2}$ each.

Gloucestershire have defeated Wiltshire in the semi-final round of the Southern Counties' Competition by 10 games to 6. The final tie will presumably be against Surrey as usual.

The North *v.* South Correspondence Match is just concluding, any games unfinished on April 15 being sent to Mr. H. E. Atkins for adjudication. The full score will be given next month.

An important match between Lancashire and Yorkshire, played at Leeds on March 23rd, resulted in a win for Lancashire by $16\frac{1}{2}$ games to $8\frac{1}{2}$. Mr. Burn was playing for Lancashire; as is often the case he preferred not to take the first board. Last year Lancashire won by $20\frac{1}{2}$ to $12\frac{1}{2}$, but in 1899 Yorkshire obtained an easy victory by 20 to 11.

Mr. T. F. Lawrence has again risen to the occasion in the City of London Championship Tournament, having at present won 15 games, drawn 2, and lost 0. The other leading competitors are—Herbert Jacobs, won 14, drawn 3, lost 2; E. O. Jones, won 13, drawn 1, lost 3; W. Ward, won 13, drawn 3, lost 3; Dr Smith, won 14, drawn 2, lost 5.

A correspondent points out that the chess-board puzzle, which appeared in the March number, had been printed in these pages some years ago. It appeared in the August and October numbers of 1886, where it is described as "the fine old 64—65 fraud." The writer of the article suggests a plan for making the discrepancy less obvious by dividing it between the square and the parallelogram, instead of, as usual, allowing it to fall on one of the two. In other words, instead of taking an amount of paper equal to 64 squares, and attempting to convince the victim of the fraud that it is also equal to 65, he takes an amount equal to $64\frac{1}{2}$ squares and turns it at will into either an apparent chess-board or an apparent rectangle of 13 × 5. The rectangle is drawn first, and a thin parallelogram of an area equal to half a square is cut out from it and thrown away. For a full description of the ingenious method by means of which, as the writer claims, the discrepancy is rendered so unnoticeable that it cannot be detected, even by measurement, those interested in the matter should refer to KNOWLEDGE for October 1, 1886.

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

The yearly bound volumes of KNOWLEDGE cloth gilt, 8s. 6d., post free.

Binding Cases, 1s. 6d. each; post free, 1s. 9d.

Subscribers' numbers bound (including case and Index), 2s. 6d. each volume.

Index of Articles and Illustrations for 1891, 1892, 1894, 1895, 1896, 1897, 1898 1899, and 1900 can be supplied for 3d. each.

All remittances should be made payable to the Publisher of "KNOWLEDGE."

"Knowledge" Annual Subscription, throughout the world, 7s. 6d., post free.

Communications for the Editors and Books for Review should be addressed Editors, "KNOWLEDGE," 326, High Holborn, London, W.C.

KNOWLEDGE
AN
ILLUSTRATED MAGAZINE
OF
SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

VOL. XXIV.] LONDON: JUNE, 1901. No. 188.

CONTENTS.

ANTARCTIC EXPLORATION.

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

(*Physicist and Astronomer to the National Antarctic Expedition*).

HISTORICAL.

NOT long ago a young reporter, evidently in search of copy and the Commander of the National Antarctic Expedition, was making vain enquiries for Captain Cook at the rooms of the Royal Geographical Society. Were that great navigator alive no doubt he would be the first to withdraw the opinion expressed by him "that no man will ever venture farther than I have done, and that the land to the south will never be explored."

Cook reached the 71st parallel of south latitude in 1774, and nearly half a century elapsed before this was surpassed by Weddell, who reached 74° 15′ south latitude in 1823. A period of 18 years brings us to the memorable expedition under the command of Sir James Ross, who in 1841 passed the highest point in southern latitudes hitherto reached, and eventually attained the high latitude of 78° 4′ S. [illegible] was greatly disappointed at not being [illegible] the 80th parallel further progress south[illegible] impossible by the great ice barrier.

Although Ross coasted [illegible] barrier for 100 miles in search of an open[illegible] southward, none could be found, nor [illegible] was ever of such form as to permit a landing[illegible] described as "a perpendicular cliff of ice betw[illegible] feet above the level of the sea, without any [illegible] or promontories on its even seaward face." Upwards of 60 years have again elapsed before this has been penetrated by the members of the recent expedition sent out in the "Southern Cross" by Sir George Newnes, who found the barrier somewhat changed in position from that reported by Ross, and actually made a journey of 20 miles to the southward over it, reaching 78° 50′ S. There is no reason to suppose that Ross was mistaken in his determinations of positions, the accuracy of his observations being beyond praise. Our knowledge of the cycle of terrestrial changes in these regions is so meagre that no one can predict the magnitude of the change taking place half a century later.

FIELD OF OPERATIONS.

The two principal expeditions about to start for the Antarctic regions are under the auspices of the British and German Governments, and by mutual agreement they have decided to confine their attention to particular localities. The British expedition has had that half of the Antarctic area assigned to it which Sir Clements Markham has designated "the Ross and Victoria Quadrants," lying to the south of the Pacific and Australasia, between the meridians of 90° W. to 180° and 180° to 90° E. The German expedition will

Map: Antarctic Area showing allotments [illegible] Expeditions.

devote its attention to that half [illegible] practically opposite, that is to the Indian Ocean and Atlantic side. The area comprised under [illegible] some 6 million square miles, larger than the whole of Australia, and so vast is the region that probably the two expeditions will be nearly 2000 [illegible] apart.

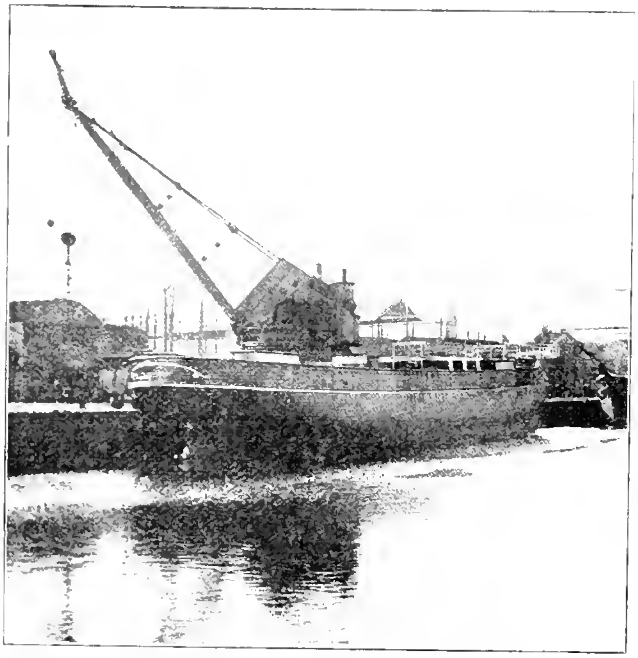
THE BRITISH SHIP.

The ship to convey the party from these shores is the

"Discovery," and is the first ship which has been specially built in this country for such Polar work. She has a displacement of 1500 tons, with engines of 450 h.p., and to suit her for a magnetic survey, no metals with magnetic properties were allowed in her construction within a radius of 30 ft. from the magnetic observatory, situated on the upper deck.

The ship, of which we give an illustration, is expected in the Thames about the end of May, and will lie in the East India Docks to receive the supply of stores and instruments.

Whilst the expedition is planned for a couple of years she will be provisioned for three, should a prolongment be necessary.



Antarctic Ship "Discovery" at Dundee (without masts).
Photograph by R. W. Skelton, R.N.

PERSONNEL.

The staff of the expedition is as follows:—Captain R. F. Scott, R.N., is the commander. Lieutenant A. B. Armitage, R.N.R., second in command, and navigating officer (of the P. & O. Company). Lieutenants C. Royds, R.N., M. Barne, R.N., and E. H. Shackleton (of the Union Castle Line Company). Mr. R. Skelton, R.N., chief engineer.

The scientific staff consists of Mr. T. V. Hodgson, formerly of Plymouth Biological Laboratory, biologist; Dr. R. Koettlitz, of the Jackson-Harmsworth Expedition, chief medical officer and botanist; Mr. W. Shackleton, from the Solar Physics Observatory, Royal College of Science, physicist and astronomer; Dr. E. H. Wilson, of St. George's Hospital, medical officer for the landing party and zoologist, and a geologist yet to be appointed. The three latter will, it is intended, be put on shore with some half dozen of the crew to form a land party. Mr. George Murray, F.R.S. (the editor of the Antarctic Manual), will proceed with the ship as far as Melbourne; and during the voyage out he will give the officers the benefit of his experience in sounding and dredging, as a preparation for similar work in the Antarctic area.

OTHER EXPEDITIONS.

Three other expeditions are in contemplation, one of which, that from Germany, is of similar magnitude to the British. The other two, one from Sweden, the other from Scotland, are of smaller dimensions.

The German ship, the "Gauss," has like features to the "Discovery," and is being fitted out at Kiel. Her programme will be carried out under the direction of Professor Erik von Drygalski, who has already done Polar work in his study of the Greenland glaciers. He will be assisted by four other scientific men.

The ship will be under the command of Captain Hans Ruser, with Herr A. Steho as engineer (both of the Hamburg-American Line).

The Swedish Expedition is led by Dr. Otto Nordenskiöld, of Upsala University. One naturally associates his name with Baron Nordenskiöld, and the discovery of the N.E. passage in the voyage of the "Vega," and he is indeed the nephew of that distinguished explorer, and has himself been on expeditions to Greenland and Alaska. His ship is the "Antarctic," and it is contemplated that in addition to Dr. Nordenskiöld she will have six scientific men on board, as well as the captain, officers, and crew. It is intended that the voyage will be made *via* Terra del Fuego, and that the vicinity of the S. Shetlands will form the arena of operations.

The Scottish Expedition is to be under the leadership of Mr. Wm. S. Bruce, who has already visited these regions in the barque "Balæna." The plans of this expedition are, however, not so far advanced as those above, but it is understood that Weddell sea will be its destination.

PROGRAMME OF THE EXPEDITIONS.

Whilst the British and German ships form the principal expeditions, the others will also support and act in harmony with them. Simultaneous observations will be made of various phenomena on term days, which have been decided upon by the committees.

For magnetic work the Cape and Melbourne will form the base stations for the "Discovery," and the Germans have decided to establish a similar station at Kerguelen Island. The detailed instructions for the British expedition are yet to be drawn up, but the general orders are in the main those with which Sir James Ross sailed. He was "to notice in the S. Atlantic the point where he crossed the curve or line of least magnetic intensity; to ascertain the depth of the ocean whenever practicable, and the temperature and specific gravity of the water at different distances below the surface; the strength and direction of currents and tides; periodical movement of the barometer; comparative brightness of stars; refraction; and to swing pendulums in special localities whereby to prove the figure of the earth. After refitting at Van Diemen's Land he was to proceed direct to the southward in order to determine the position of the magnetic pole, and even to attain to it if possible, which it is hoped will be one of the remarkable and creditable results of the expedition, one calculated to engross the attention of the scientific men of Europe."

The programme is a good one, even to-day, and needs little modification, except in so far as may be necessary to solve peculiar features of the Antarctic which have been brought to our notice by the researches of Sir James Ross and later expeditions.

MAGNETISM.

The primary object of the expedition is the completion and bringing up to date of the magnetic work done by Ross in the "Erebus" and "Terror," and by Moore and Clerk in the "Pagoda." Since that time no accurate survey of these regions has been attempted, and with the ever-changing variation of the needle by unknown amounts, navigation by the compass much south of the Cape is somewhat precarious. The utility of doing this was recognised by the Government, for which purpose a grant of £45,000 was voted. Whilst at sea the magnetic elements will be determined each day by the standard compass, and an improved form of the Lloyd dip circle specially designed by Captain Creak, R.N., for observations at sea. The Fox circle will also be employed. Absolute measurements of the magnetic elements will be made whenever possible either on the ice or on land, and the relative instruments compared with them. For the land party recording magnetographs of the Eschenhagen type will be set up, a similar set of instruments being taken by the German expedition; thus indelible records of the variations will be obtained.

Atmospheric Electricity.

The observations for the quantity of electricity present in the atmosphere will be made by means of Lord Kelvin's portable electrometer, standardized at Kew with the large self-recording instrument there; the records will thus be comparable. In addition to this, Exner's portable electrometer will also be used.

Aurora Australis.

The sympathetic disturbances of the magnetic needle with auroral phenomena has long been noticed, and therefore, as in the German expedition, special attention will be paid to magnetic observations when there is a display of Aurora Australis. In addition to this, measurements of its altitude will be made, its form carefully noted and photographed, if possible, together with spectroscopic observations, both visual and photographic. Photometric and polariscope observations will also be instituted. The relation of the Aurora Australis to that of the Aurora Borealis is of special importance in the connection between these terrestrial, electrical, and magnetic phenomena. Prof. Gyllenskiöld has shown that the folding of the Arctic Auroræ is always in the same direction, and from the results of the recent Iceland expedition, Prof. Schemer has shown the undoubted coincidence of the negative pole spectrum of nitrogen with that of the aurora. It now remains to be seen whether the folding of the Aurora Australis is in the same direction, and whether it is the positive or negative pole spectrum that is coincident. The chief aurora line will be directly confronted with that most promising line given by the new gas Krypton, and for this purpose Prof. Ramsay has kindly presented the expedition with supplies of this rare element.

The frequency of Antarctic auroræ is as yet little known, for whilst the observers in the "Antarctic" and "Southern Cross" report bright and frequent displays, those in the "Belgica" state that the displays were feeble and infrequent. The explanation of this apparent discrepancy is probably that the two former ships were in the region of greatest auroral intensity.

Geodetic Observations.

The equipment of the British expedition for geodetic and astronomical observations is in the main similar to that of the German expedition. For the determination of position the means employed will be in accordance with the situation and the accuracy required. At the shore base station a small transit instrument will be set up, and a portable altazimuth will be kept on board for accurate observations which it may be required to make on ice or at other landing places where the pendulums may be swung.

Two sets of ½ seconds pendulums are already being swung at home base stations, first the Helmert type at Kew and the Elliot [illegible] the Victorian Government at Melbourne [illegible] sets will probably remain on the [illegible] be made at one or two places where [illegible] possible to set them up; the other set will [illegible] and swung in the shore hut.

Gravity results in the Antarctic [illegible] notable, for among the results of the Nansen expedition one of the most important is the considerable [illegible] depth found in the Arctic area. On the contrary it is supposed that the Antarctic glaciers rest on an uplifted continent, which in an exaggeration would give the figure of the earth the form of a top, and it has been suggested that whilst the flattening of the earth is [illegible] in the northern hemisphere, the value [illegible] will in probability more nearly represent the flattening of the polar diameter in the southern hemisphere. As the precession of the equinoxes and nutation are products of the earth's figure this result is interesting both to astronomers and geographers.

Meteorology.

Regular meteorological observations will be made throughout the voyage, as well as at the land station, and in addition observations of the upper regions will be attempted by the aid of kites both on sea and land. Self-recording apparatus will be employed in the shape of barographs, thermographs, anemometers, sunshine recorders and hygrographs. Some work will also be done on clouds visually as well as photographically. Observations with Aitken's dust counter will also be attempted.

In the case of temperatures on shore, platinum thermometers connected electrically with the interior of the hut will be used, both embedded in the earth and ice if possible, with one also in the thermometer screen; by this means the necessity of leaving the hut to read the thermometers when the climatic conditions are dangerous will be avoided.

Should the expedition be able to reach McMurdo Bay for the establishment of the shore observatory, it is highly probable that the low-pressure belt girdling the Antarctic would be passed, and that the conditions would be more favourable for wintering if the anti-cyclonic area over the South Pole exists. At all events it was the east-south-east winds which caused an invariable rise in temperature as recorded at Cape Adare by the "Southern Cross" expedition.

Oceanography.

It is proposed not to carry on deep-sea observations on board the German ship to a greater depth than 1000 metres, but in this country it was thought advisable to go to much greater depths, and consequently the "Discovery" has been equipped for sounding and dredging to such depths as are likely to be met with. One of the things of first importance is to determine the origin and direction of movement of the great ice barrier, and everything that is feasible will be done to secure this. Soundings will of course be made as near as possible to its face, in order to determine whether or not it rests upon the bottom.

For the collection of specimens various dredge and tow nets will be employed, and for the collection of samples of sea water (for the determination of its physical properties) in which such specimens [illegible] the Pettersson-Nansen insulating water-bottle [illegible] be used. On the voyage out some studies of phosphorescence may be made, and here the work of the physicist and biologist will be united. For the study of oceanic circulation observations will be made on the salinity of the water from various depths.

as well as upon the temperature determined by deep-sea thermometers. Observations of waves will also be attempted, the article for the Antarctic Manual on this subject being written by Captain Wilson-Barker, R.N.R., some of whose results on wave observations are given by Mr. Cornish in KNOWLEDGE for May (page 97).

Observations of the tides will be of extreme importance, for it is in the great southern ocean that the tidal systems of the earth have their birth, and here maybe the tidal effects are more approaching the state that would exist were the globe entirely covered with water. The prediction of tides by applying various factors for local conditions to the theoretical conditions of attraction is a problem of no mean order.

There are many other problems to be attacked, but it is beyond the scope of the expedition to do all that might be of interest. But among the many things that may be attempted if time and circumstances permit, is the study of the variation of carbonic acid in the atmosphere. Determinations of the amounts of this gas in the air of regions devoid of vegetation would be of high importance in testing Schloessing's theory of glaciation.

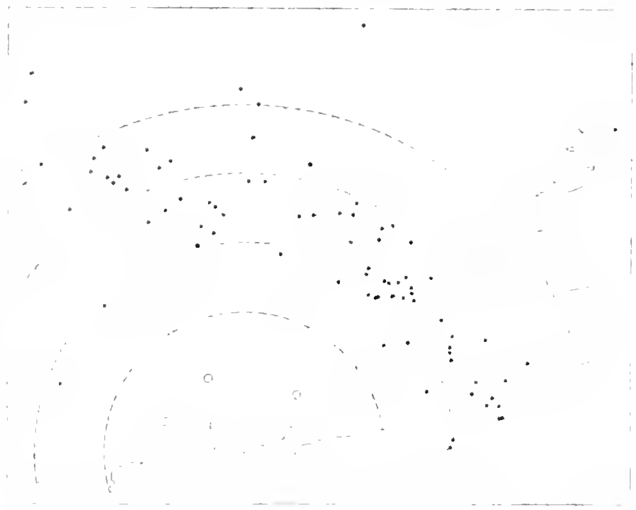
Another series of observations which might be made, should the expedition not return previously, are those in connection with the total eclipse of the sun, September 20, 1903. The maximum duration of totality is $2\frac{1}{4}$ minutes, and the central line, although starting in longitude 40° E. and latitude 46° S., does not touch land until it reaches the Antarctic area near the hypothetical Termination Is., it then passes over unexplored territory, and leaves the earth somewhat south of the volcanoes Erebus and Terror.

ON THE AUDIBILITY OF THE MINUTE-GUNS FIRED AT SPITHEAD ON FEBRUARY 1.

By CHARLES DAVISON, SC.D., F.G.S.

WHEN H.M.S. "Alberta" left Cowes on the afternoon of February 1 with the body of our late Queen, its course to Portsmouth lay to the south of a line of thirty men-of-war, ranging from third-class cruisers of about 2000 tons to first-class battle-ships of 14,900 tons. The ends of the line, indicated by crosses on the map, were occupied by the "Alexandra" on the west, and the "Majestic" on the east, the two ships being about eight miles apart. A shorter line, to the south of the other, was formed by the foreign ships of war and a group of torpedo-gunboats. As soon as the funeral procession left Cowes, about 3 p.m., a gun was fired from the "Alexandra," after which minute-guns were fired from the "Majestic," the other ships taking their time from the latter. Each ship stopped firing as the tail of the procession passed it, thus causing a gradual fading away in the intensity and duration of the reports. As the yachts rounded the "Majestic," the minute-guns were continued from the coast-defences and men-of-war in Portsmouth Harbour.* I am indebted to the Secretary of the Admiralty for the information that 6-inch guns were used with blank charges of 7 lbs. large grain powder. The guns, he adds, could not be fired simultaneously, but several were fired practically together, which would account for the reports occasionally sounding louder.

During the days succeeding the Funeral, many letters or abstracts of letters appeared in *Nature*, the *Times*, the *Daily News*, and especially in the *Standard*. The editors of the last two papers and of others published in the southern and midland counties kindly inserted requests from me for notes of observations. The total number of records from all sources at my disposal amounts to 97 from 84 places. These places are represented by dots on the accompanying sketch-map. There are also others, indicated by small circles, where, so far as known, not a single report was heard. The circular



arcs are drawn with the position of the "Majestic" as centre, and radii of 40, 60, 80, and 100 miles.

Most of the distant records of the minute-guns are unusually trustworthy, owing to the regularity of the discharges and the peculiar character of the reports. As a rule, a loud boom was heard, due to the nearly simultaneous discharge of several guns, followed by a rumble, lasting in some places for twenty seconds, as ship after ship along the line uttered the note of mourning.

From east to north-west, the places where the sounds were heard are scattered fairly uniformly between the 60 and 80-mile circles. Beyond the limit of the latter circle, they diminished rapidly in number, except in the neighbourhood of Cheltenham, where one newspaper editor, less sceptical than others, published my request for information. It should be mentioned that some of the most interesting accounts which appeared in the daily press were so far curtailed as to omit distinct reference to the minute-intervals; among this group being the records from Shelford (near Cambridge, 111 miles from the "Majestic"), St. Ives (Hunts., 118 miles), and Holme (near Peterborough, 125 miles). But there can be no doubt in this respect as to the observations from Northleach (82 miles), Kingham (near Chipping Norton, 84 miles), Egginton (near Leighton Buzzard, 84 miles), Moreton-in-Marsh (90 miles), Bishop's Cleeve (near Cheltenham, 93 miles), Alderton (near Winchcombe, Glos., 95 miles), and Alderton (near Woodbridge, Suffolk, 139 miles).

At several places the vibrations were occasionally strong enough to make windows shake. This occurred at Lingfield (56 miles), Sutton (58 miles), Wallington (58 miles) and Richmond Hill (61 miles), in Surrey; at Tunbridge Wells (65 miles) and Hayes (66 miles) in Kent; at Ashford (55 miles) and Pinner (67 miles) in Middlesex; and at Great Missenden (69 miles) and Ludgershall (77 miles) in Buckinghamshire.

While the sound-waves were thus heard at great distances, it is remarkable that in the immediate neighbourhood of Spithead they were almost or quite inaudible. The nearest place to the "Majestic" from

* Most of the above details are taken from the admirable account which appeared in the *Times* for February 2nd.

which I received any record is Horley in Surrey, distant 50 miles. It does not of course follow that reports were never heard at a less distance, for most persons so situated would imagine their observations to be of little consequence, but the undoubted fact remains that many who went out to listen to the guns returned home disappointed. Thus, one correspondent, who was on a steamer just outside the line of battle-ships, could hear only the reports from the vessel nearest to him. At Portsmouth, the first signal that the procession was approaching the harbour came from a gun fired from the "Victory," which is stationed there; for even the sound of the guns on the coast defences were scarcely audible in the town. It is said that not a report was heard at Chichester (15 miles from the nearest battleship), Midhurst (22 miles), Winchester (20 miles),* Fritham Plain (2 miles N.W. of Lyndhurst, 16 miles), Newbury (44 miles), Bournemouth (27 miles), and Yarmouth (I.W., only 10 miles).

There can be little doubt, I think, that the varying direction of the wind over the southern half of England is mainly responsible for this curious result. If there were no wind, and the temperature were uniform, the sound-waves from any gun would be spherical and the sound-rays rectilinear. If the velocity of the wind were uniform throughout, this would also be the case, though the sound would be heard slightly further in the direction towards which the wind is proceeding than in the other. But if, as usually happens, the velocity of the wind increases with the height above the ground, the sound-rays are no longer rectilinear. Those travelling in the direction from which the wind is coming are bent upwards, while those travelling in the same direction are bent downwards. In the former case, the sound-rays pass over the heads of observers at a moderate distance; in the latter, rays which started upwards at a small angle are brought down again to observers at a considerable distance. They are thus audible at much greater distances than if there were no wind, and besides travel as a rule along unobstructed paths.

Now, on February 1, the wind at places to the west of Spithead was generally light and from the west or nearly so, though near Lyndhurst there was a fresh breeze from about W.N.W. or N.W. At Portsmouth, again, the wind is described as from the shore. On the other hand, many of my correspondents at great distances from Spithead state that the wind, when sensible, was southerly in direction. Thus, the sound-rays were first of all refracted by contrary winds over the heads of observers between 10 and 45 miles, and were afterwards brought down again by favourable upper currents, so that the reports were clearly audible beyond 50 miles and up to 140 miles from Spithead, and were so loud at a distance of 81 miles that labourers in the fields put down their spades and listened.

* Winchester lies in a hollow, and, at other times, guns are, I am informed, often heard upon the Downs while they are inaudible in the city.

FLOWERING PLANTS,

AS ILLUSTRATED BY BRITISH WILD-FLOWERS.

By R. Lloyd Praeger, B.A.

III.—FLOWERS.

Having briefly considered the uses and the architecture of the roots, stems, and leaves of plants, we now come to examine the floral structures. Here we find an elaboration of design, a wealth and variety of shape and colour, a specializing of organs to meet peculiar requirements, which must strike with admiration the most casual observer. The root, stem, and leaves which we have been considering have for their purpose the contributing to the success in life of the individual, and only indirectly, according as they minister to the life and health of the individual, do they in most cases contribute to the continuance of the race. Flowers on the other hand are especially concerned with the life of the race, not of the individual. If we cut off every blossom of a plant before it reaches maturity, the health of the plant will be in nowise injured; but seed will not be produced, and carried to its ultimate limit, such practice would eventually lead to the extinction of the species. We now begin to see why plants (so to speak) indulge in such an elaborate expenditure of care and ingenuity in the designing of their flowers: the hope of future generations rests in these delicate and marvellously beautiful structures, and on their success in carrying out their appointed part in the production of copious and perfect seed.

For our present purpose, the essential nature of a flower may be broadly defined in a very few words. A flower is a group of modified leaves, of which the essential parts consist of male and female elements, the male element consisting of pollen-producing organs, while the female consists of the young seed and its accompanying structures. The male organs, or *stamens*, at the proper time liberate grains of pollen, which on reaching the receptive surface of the female organs, grow down into the embryo, or young seed, and the union of these elements is followed eventually by the production of perfect seed. Surrounding these essential organs there are generally other leaves, of very varied shape, size, colour, and number—the sepals and petals. The function of these is largely protective, and often attractive; sometimes, as we shall see, repellant; and it is to these protean outer portions of flowers that our attention will be mainly directed. Now, although a large proportion of flowering plants produce male and female organs in the same flower, it is generally essential for the production of fertile seed that each flower should be fertilized, not with its own pollen, but with the pollen of another flower—that *cross-fertilization* should be effected. This implies the transfer of pollen from one blossom to another; and in the manner in which this transfer is effected we have the key to the mystery of the infinite variety of shape and colour that we find in flowers.

To begin with a simple case. The flowers of grasses consist each of several small chaffy green leaves, which enclose the male and female organs. The flowers are usually arranged in little groups, each group forming part of a large branched colony of flowers, or inflorescence; each individual flower is small and inconspicuous. The function of the outer parts of the flower is purely protective; they keep the essential portions warm and dry, and safe from the attacks of animal enemies. While the outer portions are thus minute in size, the essential portions—the stamens, and the receptive portion of the female organ, or *stigma*—are well developed and comparatively conspicuous, and project, when the flower is mature, far out into the air. Why is this? The grasses rely on the wind to carry the pollen from one flower to another. The stamens are large and long, that plenty of pollen may be launched on its journey free from surrounding obstacles. The stigma likewise projects, that it may have the better chance of intercepting the floating grains. In such flowers an abundant supply of pollen and projecting anthers (as the pollen-bearing portions of the stamen are called) and stigmas are the most serviceable modifications; and these requirements we find amply supplied in all such anemophilous or wind-fertilized flowers.

This plan of wind-fertilization, however, which was no doubt that employed by all the primitive flowering plants, and is still used by a very large number of them, possesses disadvantages which are sufficiently conspicuous. There is an enormous waste of pollen, because even under favourable conditions, for one grain which reaches the stigma of another flower of the same species, perhaps a hundred, perhaps a thousand, perhaps ten thousand, find other resting-places; and in inclement weather the waste of pollen must be prodigious. It is quite clear, therefore, that a great advantage would be gained could some means be devised for the direct and more certain conveyance of pollen from flower to flower; and this medium of communication is supplied by certain insect visitors. The attraction that led the insects to the flowers in the first place was no doubt this same pollen which they used, and which many still use, as food.

Wind-fertilized plants: [illegible] (*Typha latifolia*) [illegible] Reed Meadow-grass (*Glyceria aquatica*). Very [illegible] flowers [illegible] size and [illegible].

[illegible] R. W.

The excessive consumption of pollen, however, might readily prove a source of injury which would more than balance the gain derived from the insect-traffic. It became necessary, therefore, to provide a counter-attraction, which would induce the insects to [illegible], and to multiply their visits without the destruction of so much pollen. Sugar, in the shape of honey, was selected as a convenient and attractive offering to the insects, and in a large number of insect-visited flowers organs were developed whose special function is the providing of honey for the visitors. Thus equipped with a tempting stock-in-trade, the next duty was to advertise it. In this connection is it that flowers have undergone their most striking transformations. The insects' senses both of sight and smell were appealed to. The outer whorls of the flower, whose functions had been formerly chiefly protective, were enlarged and coloured, till they became highly conspicuous; and scent was produced, of various sorts, according to the kind of insect visitor which it was intended to attract; and by degrees a very high degree of specialization has been attained. Let us take a few instances. In our common Buttercups the outermost whorl of flower-leaves, or *calyx*, is green, not very large, tough, and hairy. It safely encloses the whole blossom till the latter is ready to burst open, keeps it warm and dry, and provides a defensive armour against nibbling insects. When the blossom expands, the calyx in some species falls off, its duty completed; in other species it remains. The next whorl, or *corolla*, is composed of brilliant yellow petals of considerable size and wonderful lustre, which render the flower in the highest degree conspicuous. These petals have a protective as well as an attractive function, for at night, or in rainy weather, they close like a hood over the inner essential portions of the flower, and protect them from cold and wet, opening again as soon as sunlight comes, and insects are on the wing. The numerous pollen-bearing organs, or stamens, are arranged in a ring inside the corolla, and in their turn surround the female organs, which, in the form of numerous separate *carpels*, are set on a kind of cushion in the centre of the flower. An insect visiting such a flower alights inside the cup-shaped corolla, and as it turns about in search for honey (which is secreted near the base of the petals and stamens) it rubs the under-surface of its body against the upper receptive portion of the carpels, depositing thereon some of the pollen which it has presumably picked up in visiting another flower previously, at the same time dusting itself with the pollen of the flower which it is now engaged in plundering. This general description will apply with slight modifications to a large number of our wild-flowers and their mode of fertilization—for instance, to our Stitchworts, and Wild Roses, and St. John's-worts, and the many Umbelliferous plants; but it will be seen that even in these flowers there is a considerable waste of pollen and honey. Both lie open to all comers. The honey may be stolen by small insects which do not fly from flower to flower, but have crawled up the stem, or by others whose minute size allows them to get at the honey without disturbing or touching the anthers or stigmas. And, again, both pollen and honey lie exposed to the weather. In *irregular* flowers—such as the Peas and Vetches, Snapdragons, Deadnettles, and Orchids, we find a much more specialized flower-structure. The flowers, instead of being cup-shaped, with their entrance vertical, are of various peculiar shapes, and have their entrances horizontal. Examine the blossom of the common Gorse. One large showy petal extends horizontally across the top of the flower, forming a protective roof. Two smaller ones stand vertically one on each side below this. The remaining two petals form the bottom of the flower, and are joined by their lower edge so as to form a boat-shaped structure. The group of long curved stamens and pistil lie along the bottom of this *keel*. The pollen is shed, in part at least, before the flower attains maturity, and falls into the bottom of the keel. A suitable insect, say a bee, visiting the flower, is bound, owing to its peculiar shape, to alight on the keel. Its weight, by depressing the keel, causes the tip of the stigma to slide out beyond the end of the keel, pushing before it some of the fallen pollen, and both come in contact with the under side of the bee's body. It is clear how much more certain and economical this device is than the lavish scattering of pollen carried on by the Buttercup. And here we notice a discrimination on the plant's part between suitable and unsuitable insects—a feature which becomes remarkably developed in many of the more highly specialized flowers. They cannot afford to give honey and to dust pollen on every visitor, and along with arrangements made to suit welcome insects may be found an equally elaborate series of precautions against the visits of insects which do not assist fertilization. Crawling animals constitute a large proportion of these unwelcome guests, for in the tedious journey down the stem, perhaps across rough ground, and up a neighbouring stem, whatever pollen had adhered to the body, say of an ant, would inevitably be wiped off before the insect reached another flower. Such useless visitors are kept away from flowers by various devices—by palisades of downward-pointing bristles, and entanglements of hairs or down, on the stems or on the calyx; by quagmires of gummy excretion; sometimes even by means of a moat full of water, as in the case of the Teasel. How effective these barriers are a little observation will show. Prof. Kerner counted small animals of sixty different kinds—beetles, flies, ants, bugs, ichneumons—trapped by the sticky stems of *Silene nutans* in the Tirol; and the viscid hairy stem and calyx of a Moss-rose must prove a practically impassable barrier to would-be explorers. Often the protective appliances are found in the blossom themselves, and this brings us back to some of the irregular flowers which we were considering. The Snapdragons and Toadflaxes exhibit a simple and complete method of protection from small prowlers. The flower is shaped like a mouth, with two closed lips; the pollen and honey are in the interior cavity. It is only an insect which is strong enough to force open the lips, or whose weight, depending from the lower lip, is sufficient to depress it, which can reach the interior of the flower. In other cases the stamens form a ring which must be pushed aside before the honey is reached. The encouragement of useful insects and the discouragement of useless ones go hand in hand.

The Salvias furnish a pretty case of exact adjustment for their insect visitors. The flowers are exceedingly irregular, the upper part of the corolla forming a high arch over the flower, the lower part forming a broad landing-place for the insects. The corolla is prolonged downwards into a narrow tube, at the extremity of which is the honey-well. The stamens and *style*, as the stalk of the stigma is called, curve along the arched roof of the flower, above the entrance. The stamens are hinged near the end, the free portion being prolonged downwards, and hanging in the entrance. When an insect alights on the platform, and inserts its head into the flower in order to draw honey from the well, it pushes the end of the hinged portion of the stamens inward and upward, with the result that the opposite end, which bears the pollen, swings downward and strikes the hind portion of the insect's back. And there is a further point. It has already been noted that most flowers, in order to produce perfect seed, should be fertilized not with their own pollen, but with the pollen of another flower of the same species. In the Salvias the stamens are ripe and shed their pollen before the stigma is in a receptive condition, and in this way (as in a great many other flowers) self-fertilization is avoided. But the style continues to grow, and by the time the stigma is mature it has outgrown the stamens, and occupies exactly the position which the stamens occupied on striking the insect's back. So that our insect on visiting a slightly older flower, brushes the stigma with precisely that portion of its back on which the pollen was deposited. It [illegible] a small insect visiting this flower [illegible] the stamens or stigma, under which it [illegible] the honey-well which it would find too [illegible] its entrance, and too deep to be sounded [illegible] proboscis. It would go away having [illegible] pollen nor the honey.

It is in the Orchid tribe that [illegible] this kind has been carried furthest, and in these points we

Insect-fertilized flowers, showing conspicuous effect produced (1) by great enlargement of the corolla (*Convolvulus*), and (2) by the grouping in a large umbel of numerous smaller flowers (*Angelica*).
Photograph by R. Welch.

find an ingenuity of design, and a wealth and variety of form and colour, that are unequalled in the vegetable kingdom. Some of the common Orchids of our meadows will exemplify their structure quite as well as the most gorgeous Brazilian species. Examine one of our common British Orchids, such as *Orchis maculata* or *Habenaria bifolia*—they are just coming into bloom now. The calyx consists of three sepals, the corolla of three petals—all are coloured similarly, but differ in shape. It must be pointed out that these flowers, when mature, are all upside-down, as we may see by opening a bud, and comparing the relative positions of the parts with those of an open flower. This inversion of the flower is caused by a twisting of the ovary or seed-vessel, which is long, and looks like the stem of the flower; this twisting also we may observe by comparing the ovaries of a bud and of an open blossom. The large petal which, in the bud, is topmost, and folds over the other portions of the flower, in the open blossom is lowest, and forms a broad landing-stage. Two sepals stand one on either side; two petals and the remaining sepal form the roof of the flower. The lowest petal is prolonged backwards into a deep narrow honey-well. So far the flower resembles in many respects that of the Salvias described above. But when we look for the stamens and pistil we find an extraordinary structure. The pollen-grains are fastened together into two oblong bundles by means of slender threads, and each bundle is prolonged into a delicate stalk, the tip of which is enlarged and coated with viscous fluid. The whole is embedded in the wall of the flower, over the honey-well, and facing the entrance, and the sticky termination of the stalk alone is exposed. The stigma is likewise embedded, and shows a sticky surface below the position of the stamen. How does this structure work? A bee alights on the platform and pushes its head into the entrance to the tube. Its forehead comes in contact with the sticky extremities of the embedded pollen-masses, and on withdrawing, it pulls one or both of these out of the grooves in which they rest: the bee flies off with the pollen-masses sticking on its forehead like two horns. And now a remarkable thing happens. Owing to unequal shrinkage caused by drying, the stem of each pollen-mass curves, so that instead of standing upright they now project forwards. In consequence, when the bee visits another flower, and inserts its head, the pollen-masses come in contact, not with that part of the flower which encloses the pollen, but with the sticky stigmatic surface below, and thus fertilization is effected. The absolute accuracy of the method, the economy of pollen, the way in which the plant is entirely dependent on the visits of the right kind of insect for its fertilization, show that here we have reached the very acme of specialization in this direction. It is to be noted that along with the modification of the plants to suit insect-visitors, considerable modification in the structure of the insects has taken place to suit their honey-sipping habits, so that now many are as dependent on the flowers for their food, as the flowers are dependent on insects for their fertilization. There is a complete symbiotic interlocking between the representatives of the animal and vegetable kingdoms.

It is the most highly organized plants that lay themselves out to attract the most highly organized insects. Simply-constructed flowers like the Buttercups and Umbellifers, which have their honey and pollen openly exposed, are visited by a motley crowd of flies, beetles, ants, and other insects, and these flowers are largely yellow or white in colour. With more specialized flowers come preventive measures, and the encouragement of certain groups of winged insects; while the most highly developed flowers lay themselves out exclusively for the attentions of the aristocracy of the insect world—the bees, butterflies, and moths; and from the simple yellows and whites of the lower flowers they turn to the richer tones of red, and purple, and blue.

CONSTELLATION STUDIES.

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

VI.—THE SWAN AND THE EAGLE.

One feature of the primitive constellations, whatever its significance, cannot escape the most casual notice. Many of the forms, indeed most of them, are duplicated, and when thus repeated the twin symbols are, as a rule, not widely separated but placed close together. The portion of the sky to which we have now come is the home of the birds. Here, Aratus tells us

"There is in front another Arrow cast
Without a bow; and by it flies the Bird
Nearer the north. And nigh a second sails
Lesser in size, but dangerous to come
From ocean when night flies; the Eagle named."

In the midnights of early June, the great stream of the Milky Way crosses the sky from due south to due north, not passing, however, through the zenith but somewhat to the east of it. Right in the centre of this magnificent arch, forming its very keystone, is the constellation of the Swan, easily found from its neighbourhood to Vega, Alpha Lyrae. The figure of the "Bird," or as we now know it, the "Swan," may be easily traced out. A long undulating line of bright stars lies parallel to the axis of the Milky Way, skirting the western edge of the great channel which here divides it. This represents the outstretched neck, body, and tail of the flying Swan. Crossing it at right angles, is another undulating line of stars which represents the outstretched wings of the flying bird. The whole constellation has often been termed from its shape the "Northern Cross." Beta Cygni marks the extreme tip of the Swan's bill, and lies about as far beyond Gamma Lyrae as Gamma is from Vega. Its name is usually given as Albireo, but the meaning and derivation of the word is obscure, and is almost certainly due to a mistake. The Arabic name is Al minkar al dajajah, the "Hen's Beak." It is one of the loveliest double stars in the entire heavens; the principal star, of the third magnitude, being topaz yellow, the companion, of the seventh magnitude, sapphire blue, and the distance, 35", being within the power of a field-glass.

Gamma, the bright star which marks the intersection of the cross, is the centre of a most interesting region. The whole extent of sky from Beta to Gamma is perhaps the richest in the entire heavens, and Gamma itself is in the midst of rich streams of small stars, interspersed with some strikingly definite dark lanes. Of the transverse beam of the cross, Epsilon marks the eastern arm, Delta the western, and from Gamma to Epsilon we find one of the most remarkable gaps in the Milky Way, the "Coal Sack." Alpha has been called Deneb Adige, the "Hen's Tail," or Aridif, the "hindmost" or "follower," both titles appropriate enough to its place. The entire region of the constellation is full of interest and beauty, whatever the optical power with which it is examined, from the naked eye up to the greatest telescope. One of the many interesting objects in the region is Omicron. To the eye a double star makes a trapezium with Alpha, Gamma and Delta; the brighter of the members of this double, Omicron, in the field-glass will be seen to have two companions, one on each side, both of them blue, whilst the chief star is orange.

Aratus gives the constellation simply as the "Bird," without naming its species, but Eratosthenes defines it as the "Swan," and its length of neck well agrees with the identification. Dr. Lamb's somewhat doggerel rendering of Aratus enlarges upon his author in this connection to bring in absolutely without warrant the story of Leda and Zeus. The second bird is, however, plainly identified as the Eagle, and its chief star, Altair, forms the third point of a roughly equilateral triangle, the other two angles of which are marked by Vega and Alpha Ophiuchi. It is also easily identified by the two smaller stars, Gamma and Beta, above and below it; these making with it a characteristic figure of three bright stars in a straight line, on the borders of the Milky Way. The three stars bear the following names. The middle one, Alpha, is Altair the "Bird," that is the "Flyer"; the "Soaring Eagle," as contrasted with Vega, the "Swooping" or "Falling Eagle"; the southern star is Beta, Alshain, the "White

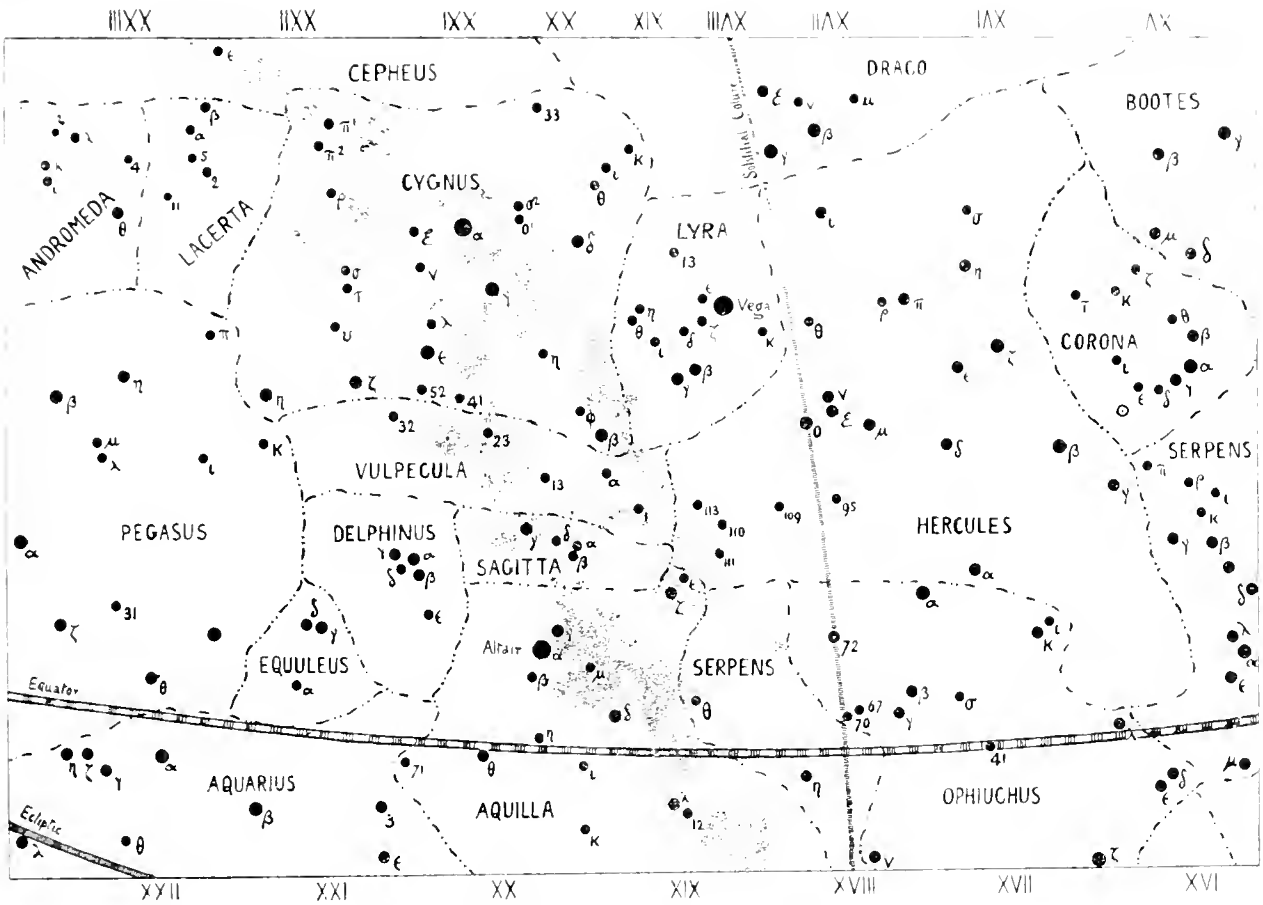
Falcon"; and Gamma, the northern star, Tarazed the "Robbing one."

The rest of the constellation can be made out without much trouble, but the figure is by no means so good as that of Cygnus. Two stars, Zeta and Epsilon, near together, mark the tip of one wing in the north-westerly direction, and a very much fainter pair, 70 and 71, mark the tip of the other wing, about the same distance on the other side of Altair. Proceeding from Gamma down the Milky Way, we find Mu, Delta and Lambda, reproducing roughly the arrangement of stars which to that in which he is [illegible]. [illegible] the explanation of the phrase [illegible]

[illegible]

nor can either of the three heroes [illegible] near at hand, the Herdsman, the Serpent holder or the Kneeler have despatched it. The Herdsman [illegible] his crook, the Serpent holder has both hands full of the twining snake and if we accept the guess of Panyasis that the Kneeler was really Hercules, Germanicus tells us that one hand held a club, the other a lion's skin.

Parallel to the Arrow, and of not much larger extent



Star Map No. 6: The Region of Cygnus.

marks so clearly the neck and head of the Swan. Following the line of the three stars, Alpha, Beta, Gamma, we find they point downwards to a bright star, Theta; between this and Delta, but nearer to Theta, is Eta, one of the regular variable stars of short period, visible in all its phases to the naked eye, its period being one of four hours over the week.

The quotation from Aratus at the head of this paper refers to a little constellation which in a certain sense is the most interesting in the entire sky, the constellation of the Arrow. Possessing only five little stars of the fourth magnitude, and extending in a narrow line, but 4° in length, increased by the moderns to 10°, it is nevertheless one of the oldest constellations, being mentioned three times by Aratus in his celebrated poem, and having its five principal stars duly catalogued by Ptolemy. The history of the Arrow was lost even in the time of Aratus. It was not shot by Sagittarius the Archer; so much is quite clear, for it is flying high above his head and in the opposite direction

is the modern constellation, Vulpecula, framed by Hevelius in 1690. Its principal interest to the naked-eye observer is the meteor stream which radiates from it in the latter half of June, and to the telescopic observer the celebrated Dumb Bell nebula, just visible in the field-glass. A line from Alpha Ophiuchi through Zeta Aquilae, and another from Alpha Cygni through Epsilon Cygni, will meet together in a pretty little constellation, which, once picked out, can never be forgotten, its leading stars being so nearly equal in magnitude and so close together. This is the constellation of the Dolphin, containing ten stars in Ptolemy's catalogue. Two of these are a little brighter than the fourth magnitude, and seven others range from that down to the fifth. Alpha, Beta, Gamma and Delta form a compact little lozenge, the straight line of Gamma and Delta being continued on by Zeta and Epsilon. Though the Dolphin is one of the ancient constellations, the names attached to the two principal stars are quite modern, and are due to a piece of very clumsy humour on the part of Piazzi, the Sicilian astronomer. In his catalogue he introduced for these two stars the names

The Midnight Sky for London, 1901. June 2.

Rotanev and Svalocin, names which gave a good bit of trouble to etymologists until it was seen that they were simply the name of Piazzi's assistant Niccolo Cacciatore, latinized and spelt backwards

NEW STARS.

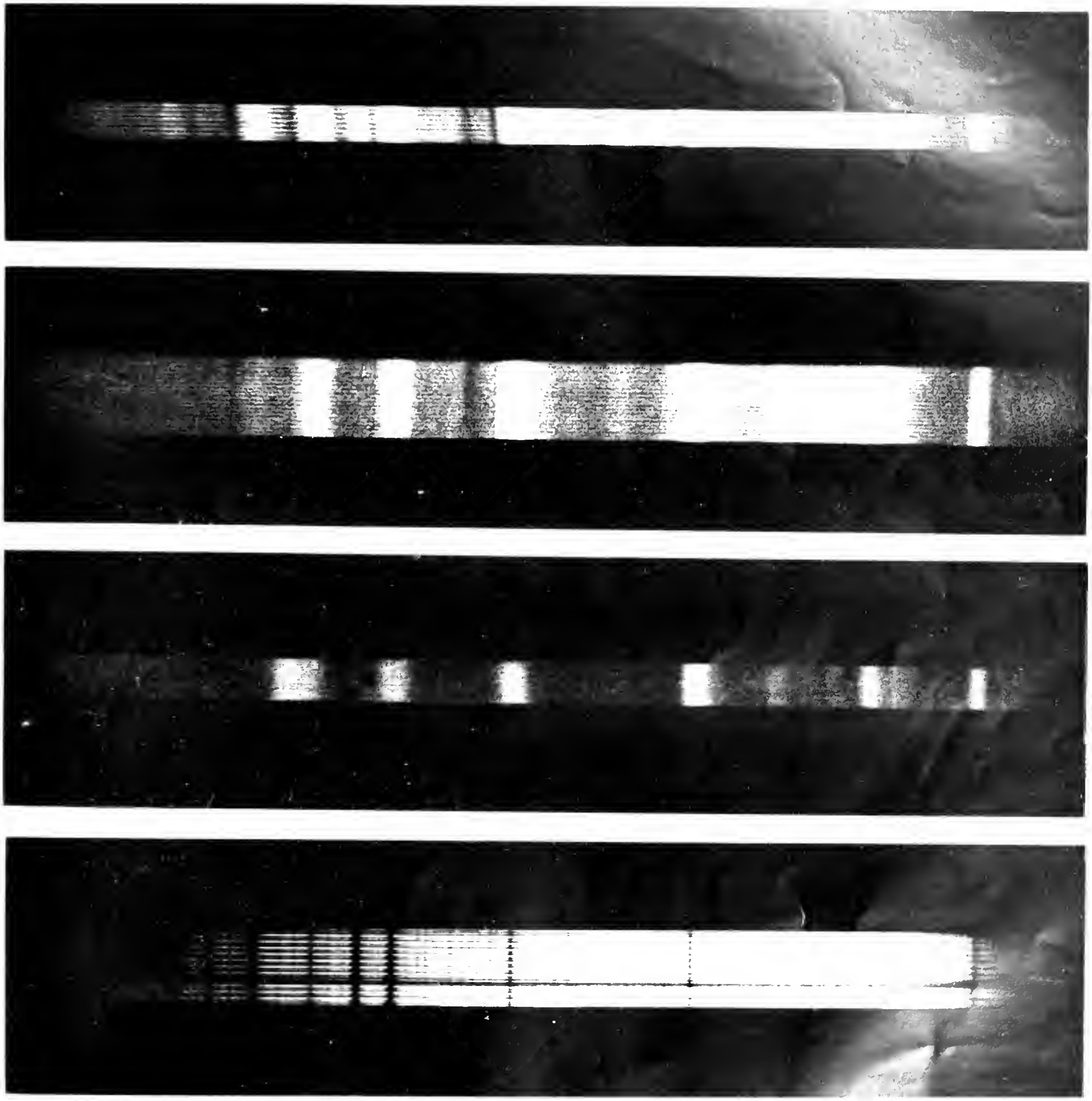
By the Rev. A. L. CORTIE, S.J., F.R.A.S.

THE appearance of the brilliant star in the constellation Perseus, discovered by the Reverend Dr. Anderson, of Edinburgh, in the early morning of February 22nd, has naturally awakened the keen interest of astronomers in the subject of the origin and composition of such bodies. In the twenty centuries that elapsed between the years B.C. 134 and A.D. 1892, when the last new star visible to the naked eye, previous to the advent of the present stranger, was also discovered by Dr. Anderson, only nineteen cases of such appearances have been recorded. Another six, of small magnitude and invisible to the unaided eye, appeared on the photographic plates secured in the period 1877 to 1899 by the indefatigable director of the Harvard College Observatory, Professor E. C. Pickering. Of the first new star known to us by historical records, we learn the bare fact that its discovery was due to Hipparchus, and the interesting statement of Pliny that it suggested to the Greek astronomer the construction of a catalogue of stars, the earliest that is extant. Of the other new stars discovered before the general adoption of the spectroscope and photographic plate as powerful auxiliaries of the telescope, the most famous was Tycho Brahe's star, which blazed out in the constellation Cassiopeia in the year 1572, and was visible for a year and five months, rivalling at first Venus and then Jupiter in brilliancy. Of this star it is recorded that its colour changed from white through yellow to red, and then to white again, thus furnishing some indication of a probable fluctuation in and recuperation of its light, phenomena which have been also marked in succeeding new stars. Another Venus-like star was that observed by the famous Kepler in A.D. 1604, and visible for a year. The brilliancy of this star joined to a conjunction of the planets Jupiter, Mars, and Saturn in the same part of the heavens led the illustrious astronomer to propound the theory that it was a similar phenomenon which appeared to the wise men in the East and led them to Bethlehem. The same century witnessed yet another outburst, in the year 1670, this time near the star β Cygni, the detection of the star being due to the Carthusian monk Anthelmus. This star was visible for two years, and likewise exhibited fluctuations in its light. The century just completed was marked by five such apparitions, namely: in 1848, when a star was discovered by Dr. Hind in the constellation Ophiuchus; in 1866, when a star in the Northern Crown blazed up suddenly from the ninth to the fourth magnitude, and after again increasing its lustre six-fold in about six hours, finally became a variable; in 1876, when a star of an orange-red tint appeared in the constellation Cygnus, which attained a lustre equal to that of a third magnitude star, and which when observed by Burnham at the Lick Observatory in 1891 was a small star of 13.5 magnitude, and "at times seemed to resemble an exceedingly minute nebula"; in 1885, when a star appeared in the very heart of the Andromeda Nebula; and finally in 1892, when Nova Aurigæ was discovered. On the appearances presented by this star it will be necessary to dwell somewhat in detail, as it marked a considerable advance in our knowledge of the varying phenomena of such temporary visitants. It was certainly not of the eleventh magnitude on December 8th, 1891, otherwise it would have impressed its image on the photographic plates of that portion of the sky taken by Dr. Max Wolf of Heidelberg. Two days later it was on the plates taken at Harvard College, and was of the fifth magnitude. It attained its first maximum of 4.4 magnitude on December 20th. It then decreased slowly in brightness with slight fluctuations until January 20th, 1892, when it was somewhat below the fifth magnitude. It was first seen, and discovered by Dr. Anderson, for its prior history by means of the photographs was only elucidated subsequently to his announcement, as a fifth magnitude star on January 24. After this it received another access of lustre and attained a second maximum of between the third and fourth magnitude on February 3rd. It then steadily grew fainter, with the exception of another slight rise in magnitude between March 16-19, until at the beginning of April it was equal to a faint thirteenth magnitude star. On April 24th the Lick observers estimated its magnitude as sixteen. But in August of the same year, it again recuperated its energies, rising to the ninth magnitude, or increasing in brightness nine hundred fold.

There occurred, therefore, in this star a sudden outburst, a rapid rise to brilliancy, a fall, another rise to maximum brightness, again a fall, a third rise, though less brilliant than its predecessors, and then a rapid and persistent fall to extreme faintness. But four months after, it became an easily discernible telescopic object, its haziness of outline suggesting that it too had become a nebula.

With regard to the nova of the present year, although the observations have not yet been completed, we notice a similar sudden burst from a low to a high magnitude, at least $12\frac{1}{2}$ magnitudes in three days, corresponding to a 100,000 fold increase in its light, a similar gradual decline with fluctuations of brilliancy, so that at the end of March the star seemed to have become a variable with a period of three days.

The nova of 1866 was the first new star the light of



PHOTOGRAPHS OF THE SPECTRA OF NOVA PERSEI AND PROCYON.

STONYHURST COLLEGE OBSERVATORY

which was subjected to the analysis of the spectroscope, the earliest observations being those of Sir William Huggins and Dr Miller. The chief facts observed with regard to its spectrum were that it was compound, being composed of two series of bright and dark lines superposed upon a background of continuous spectrum, and that the bright hydrogen lines predominated. M Cornu called attention to the matching of the brightest lines in the star's spectrum by well-known lines seen bright in the chromosphere of the sun. With regard to the spectrum of Nova Cygni in 1876, Professor Vogel called attention to the extent of the spectrum which stretched far into the violet regions, the double spectrum of bright and dark lines, especially those of hydrogen, and the gradual changes in the spectrum, which had become reduced to a single line in the green, very near in position to the chief line characteristic of nebulæ, when the star had fallen to the tenth magnitude. The spectrum of Nova Andromedæ in 1885 was mainly continuous, being similar in this respect to the spectrum of the first days of Nova Persei, and, moreover, confined to the green. The spectrum of Nova Aurigæ was the first which was permanently recorded for future comparison and study by means of the photographic plate. It was a very wonderful spectrum, with many new details of its own, but still confirming all the earlier observations of the spectra of novæ. The compound or double spectrum of bright and dark lines was very striking, the more intense bright lines, especially those of hydrogen, being accompanied on their more refrangible sides by broad dark companions. The line near the position of the chief nebular line was very marked. The spectrum, too, was of great length, extending from beyond C in the red right down to the further limit of the ultra-violet. It was full of lines, the Stonyhurst photographs, which comprised the region from D in the yellow to H in the violet, showing more than 200 lines. Many of these lines, too, were of great breadth, notably those of hydrogen, extending over several tenth-metres, or units of wave-length. On an average the centres of the dark absorption lines were about 11 such units removed from the most intense points of the bright bands. The match, too, both in character and position of the lines in the spectrum of the star, and in the spectrum of the sun's chromosphere was very evident. Moreover, sharp bright lines appeared on the dark bands after the star had attained its maximum. Such an appearance is not unknown in the spectrum of sun-spots, and on the calcium lines H and K, in the solar spectrum. Lastly, when the star received an accession of light in the August of 1892, the spectrum as examined by Professor Campbell, of the Lick Observatory, was strikingly similar to that of planetary nebulæ.

The beautiful photographs of Nova Persei by which we are enabled to illustrate this paper, through the kindness of Father Sidgreaves, were taken on March 3rd at 8 p.m., on March 21st at 8.30 p.m., and on March 25th also at 8.30 p.m., by means of an objective prism of about 4 inches aperture, made by Mr Thorp, and fixed to the finder, also of the same aperture, made by Cooke & Co., of the 15-inch equatorial. A spectrum of Procyon is placed below the spectra of the nova to show the positions of the hydrogen lines or rather bands. Reading from right to left they are $H\beta$ to $H\epsilon$, the calcium line K, immediately following $H\epsilon$. Without entering into any details these photographs sufficiently illustrate the chief points to which we have directed attention in the spectra of all novæ. There are many other matters worthy of study, but beyond the scope of the present paper. There is, however, one fact with regard to the changes in the spectrum noted in Nova Persei which deserves mention, as it has never been observed before. It is that when the spectrum was photographed at Harvard and observed at Edinburgh on the night of February 22nd it was continuous and crossed by only thin dark lines. By February 24th the bright lines were well in evidence with their dark companions. This would seem to point to a sudden raising of the temperature of a dark and cold body to a white heat. Then came absorption by the vapours thrown off, giving the dark line spectrum so well known in the sun and in the stars of the Orion type and then the supremacy in radiative power of the gaseous spectrum suddenly asserted itself, and became the chief feature, as is the case in those storms on the sun which we call spots and prominences.

How then are we to account for the origin of such stars? At the outset we must frankly acknowledge that the appearances are extremely puzzling, and that so far no theory has been broached which satisfies all the conditions of the problem. For any theory of a new star's origin and constitution must needs find an explanation for the sudden outburst of light, for its fluctuations in intensity, for the complicated spectrum, its extent, its multitude of lines, the phenomena of the bright lines and their dark companions, together with their exceeding great breadth. But the crucial point of the whole problem lies in the fact that this shifting is always in the same direction, of great extent, and persists for a long time. I fancy any theories that purport to explain the appearances on the supposition of the motion either of meteors through a nebula, or of a cold dark body through luminous particles, must needs satisfy, first the enormous velocities of the moving bodies in the line of sight, some 500 miles a second at the least, if indeed the displacements observed are due to motion in the line of sight, the persistence of such velocities for months, and, most difficult point of all, their invariable occurrence exactly in our line of sight. Should we attribute the great widening of the lines to pressure, after the analogy of the laboratory experiments of Humphreys and Mohler, and of Wilsing, we do not escape the difficulty of the long persistence of such pressure, to say nothing of its enormous amount.

However, we note that the light curve of new stars is very like the curve of sun-spot frequency, with the rapid rise to maximum, and the fluctuations as the energies displayed in the initial stages of the outburst are gradually expended. Next the spectrum of new stars is in the main the spectrum of the solar chromosphere, at least in its earlier stages. Moreover, appearances very similar, though on a greatly reduced scale, to the double spectrum of new stars can be observed in the spectra of sun-spots and prominences. And it must be borne in mind that a sun-spot is only one of the forms in which the forces in the sun are displayed. For a sun-spot is always accompanied by prominences as also by faculæ at times of vast extent. It is true that in the chromosphere the lines, except at their bases, are very thin, showing that the pressure cannot be very great; but in spots the lines are widened, due no doubt to the density of the matter composing them, and, moreover, frequently shifted, perhaps the partial result of pressure. We have already alluded to the reversals to be seen so frequently in the spectra of spots and prominences, and, moreover, bands have been observed in the spectra of the former. But in spite of all these similarities we cannot claim them as anything more than suggestive of the possible lines on which the problem as to the origin of new stars is to be attacked.

NOTES.

Astronomical.—The observations of the total eclipse of the sun on May 18th appear to have been only partially successful. In Sumatra the conditions were very unfavourable, although not bad enough to completely obscure the sun. We gather that the Dutch astronomers succeeded in obtaining photographs both of the corona and spectra, but the prismatic camera did not succeed. At the time of writing there is little news from the British observers in Sumatra, but it has been reported that the duration of totality was six minutes twenty-one seconds. In Mauritius, where Mr. and Mrs. Maunder were stationed, the total phase appears to have been well observed. Fifty-two photographs of the corona and eighteen photographs of the spectrum were taken with the various instruments. The corona was of the expected minimum type.

Prof. Campbell has recently utilised the spectroscopic results obtained at the Lick Observatory for an investigation of the sun's motion in space. The conclusion is that the sun is approaching a point in R.A. 277° 30', Decl. + 19° 58', with a velocity of 19·89 kilometres per second. This velocity is considerably smaller than the average of the 280 stars on which the calculations are based, and Prof. Campbell further considers that there is evidence that the faint stars are moving more rapidly than the bright stars, and therefore that they are relatively further from us than the investigations of their proper motions have led us to conclude. Through the generosity of Mr. Mills, Prof. Campbell will be enabled to extend his researches so as to include stars invisible at Mount Hamilton by establishing an observatory in the Southern Hemisphere.

Mr. R. T. A. Innes, of the Cape Observatory, has communicated a paper to the Royal Astronomical Society in which he gives several instances of stars which have not disappeared instantaneously when occulted by the moon, some of them vanishing in two distinct stages, and others by "gliding." He points out that on several occasions double stars have been detected by the phenomena attending their occultations, and considers that disappearance either in two stages or by gliding is almost certainly due to the star being really a binary system. A particularly interesting feature of this mode of detecting double stars is that the observation can be made with telescopes of very moderate size. Mr. Innes remarks that many of the doubles which may in this way be discovered will be too close for telescopic confirmation, and may therefore form a class intermediate between visual doubles and spectroscopic binaries. Special interest attaches to the behaviour of known spectroscopic binaries, and it is suggested that careful observations should be made of the coming series of occultations of α Virginis.

In the course of a communication received from Baron Kaulbars, of St. Petersburg, it is suggested that the fluctuations in brightness of Nova Persei are due to a ring of meteors, of varying density, which surround the star. The idea seems to be that the light is dim when a dense portion of the ring is in front of the star, and bright when a sparse portion is in front. The arrangement appears to be a very artificial one, and it is difficult to understand how it can account for the changes of spectrum.

In Harvard *Circular* No. 58, Prof. Pickering discusses the interesting photometric problems suggested by the variability of Eros. Owing to the varying position of the observer with regard to the planet, it will be possible to gain much information which is inaccessible in the case of a variable star. The material already accumulated is under discussion, and the preliminary results will shortly be available for publication. In the photographs taken in 1893, 1894, and 1896 (before the existence of the planet was known), distinct changes can in some cases be traced in the brightness of different parts of the same trail. This suggests an easy method of discovering short period variability in an asteroid.—A. F.

Botanical.—A curious instance of a root being transformed into a leaf, or, at least, into an organ which apparently possessed all the usual characters of a leaf, is recorded by Professor R. A. Philippi in a recent number of the *Berichte der deutschen botanischen Gesellschaft*. Professor Philippi planted in flower-pots a number of corms of *Crocus vernus*, which he had received shortly before from Holland. These failed to show any signs of growth above the soil, which was therefore turned out of the pots, when a white piece of root, 12 cm. long and 2 mm. thick, was found attached to a piece of a Crocus-corm. He inserted the corm-end of the root in soil to the depth of 4 cm., and allowed the rest to be exposed to the light. After several weeks, a slightly elevated line was observed on the side of the root which received the greatest amount of light, and this quickly developed into a green, leaf-like body, 7 mm. in width. The function of assimilation proceeded as in an ordinary leaf. New roots were formed, and subsequently four normal leaves.—S. A. S.

Entomological.—An interesting contribution to the life-history of beetles has been made by Mr. G. C. Champion and Dr. T. A. Chapman, who publish in the *Trans. Entom. Soc. London*, for 1901 (pp. 1-18, pls. 1-2), some observations on certain species of Orina, an Alpine genus of Leaf-beetles (Chrysomelidæ), adorned with brilliant metallic colours. The statement of former naturalists that most of these insects bring forth their grubs in an active state is confirmed; such "viviparity," unusual in insects generally, is especially rare among beetles. One of the observed species (*O. tristis*), however, lays eggs which are subsequently hatched. The most remarkable fact brought to light in this paper is that, in *O. vittigera* at least, the embryos develop not in the vagina but in the ovarian tubules. Evidently the method of fertilization in these beetles must be exceptional.

Father Wasmann describes (*Zeits. f. wiss. Zool.*, LXVII., 1900, pp. 599—617, pl. 33) some remarkable flies—Termitoxenia—found in the nests of South African termites ("white ants"). These flies have the hinder segments of the swollen abdomen doubled under, somewhat like the "tail" of a crab, and the thorax is provided with appendages (suggestive of vestigial wings) whereby the insects are lifted and carried about by their hosts. This observation renders it likely that the flies supply the termites with some food-product, despite the fact that the lancet-like structure of their jaws shows them to derive their own food from the bodies of the termite larvæ. They furnish, therefore, an interesting link between the parasitic and the inquiline habit.—G. H. C.

Zoological.—In a paper on the musk-oxen of Arctic America and Greenland, published in a recent issue of the *Bulletin* of the American Museum of Natural History, Dr.

J. A. Allen mentions that the first suggestion of the distinctness of the Greenland from the American form appeared in Knowledge, in the article on the young musk-ox at Woburn. It is true that the author of that article, misled by some badly-executed photographic reproductions, did not at that time realize the constancy of the distinctive features he pointed out as differentiating young Greenland musk-ox from the American representative of the species. But in his subsequent separation of the Greenland form, on account of its white face-markings, as a local race he has been fully justified by the American material. Indeed, on account of certain differences in the form of the horns and hoofs, Dr. Allen would go one step further, and consider the Greenland musk-ox entitled to rank as a separate species, under the name of *Ovibos wardi*.

In the April issue of the *Proceedings* of the Zoological Society of London are published extracts from a letter addressed to the Secretary by Sir Harry Johnston, relative to a hitherto unknown mammal of the approximate size of a horse inhabiting the Aruwimi, or Congo, Forest in the country between Lakes Albert and Albert Edward. The animal, which is known to the natives as the okapi, was described to Sir Harry as being iron-grey, or dun, above, with the legs and underparts striped, and the muzzle greatly elongated. Mention was made of two strips of skin, which in due course reached England, and were exhibited before the Zoological Society, when the animal to which they pertained was definitely stated to be a new species of zebra. On the 7th of April a coloured sketch of the okapi was exhibited to the Society on behalf of Sir Harry Johnston. This sketch shows a hornless ruminant with striped legs and uniformly coloured body. And it is suggested by Sir Harry that the new animal may prove to be a near relative of *Helladotherium* of the Grecian Tertiary. Be this as it may, the discovery promises to be one of the highest importance, and the description of the specimens reported to be on their way to this country will be awaited with interest.

Letters.

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

STELLAR PARALLAX.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—As is well known the moon, although it revolves round the earth, does not describe a circle in space but a curve of double curvature, because as it revolves round the earth, the earth travels along its orbit round the sun; but the sun is travelling at a rapid rate towards the star marked π in the constellation Hercules, consequently the earth does not trace an ellipse in space but a similar double curve. But we are taught at college that, when the earth's orbit is taken as base line, in estimating the parallax of distant fixed stars, the fixed star seems to revolve in a very small ellipse corresponding to the orbital base line described round the sun by the earth.

How is this, when the earth really describes in space a double curve, and how is the extra length of the base line through solar translation estimated in calculating the parallax of fixed stars? W. W. Strickland.

[There is no difficulty in principle in distinguishing between the effect upon the apparent place of a star of the earth's motion every year in its orbit round the sun and the motion of the solar system in space. Thus, if we observe the place of a given star on the same date in several successive years, these places would be entirely unaffected by the annual parallax, and the "proper motion" of the star could be learnt from them. Observations at any other dates could be corrected for this "proper motion," leaving the effect of the parallax outstanding. The effects of precession, of the "sun's way" and of any actual motion in space which an individual star may itself have, are necessarily cumulative, and go on increasing from year to year; the effect of parallax is periodic, and runs through its changes in the course of a year. E. Walter Maunder.]

SUNSPOTS AND TERRESTRIAL TEMPERATURE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Will you kindly allow me space to assure Mr. Quensel that he is in error in attributing a connection between sunspots and terrestrial temperature. Your correspondent obviously cannot have read up the necessary series of meteorological observations for the past forty years, which refer to a large tract of the earth's surface. Mr. Quensel makes no mention of the places where the observations necessary for his deductions were made. Are we to infer that his remarks are applicable to the continents of Europe, Asia, Africa, America and Australia? Has he obtained a "mean" temperature from these continents, and then compared it with the sunspot curve? Certain it is that up to the present time *we have absolutely no evidence* that there is the ghost of a connection between the phenomena of sunspots and terrestrial temperature.

Louth, Lincs. G. McKenzie Knight.

[Mr. Maunder has already pointed out that Mr. Quensel's statement could not be accepted without the figures on which it was based, and we think a similar remark would apply to the assertion made by Mr. Knight. The subject is a difficult one, and it is evident that much more analysis of the observations is required before any satisfactory conclusions can be drawn. It must be remembered that the variation of sunspots is only one of the indications of varying solar activity, and that sunspot phenomena alone, therefore, need not necessarily indicate the whole change of solar radiation.—Eds.]

CLOUDS ON MARS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Allow me to correct a mistake of mine made accidentally in my letter published in Knowledge for April. The word "dark" in the letter should have been "light." In the above letter I tried to call attention to the antagonistic views of Mr. Thomas R. Waring to those of other astronomers as to the visibility of clouds on Mars. As I understand Mr. Waring he states that the atmosphere of Mars is entirely free from clouds, and if so, I should be pleased to know his opinion as to the nature of the "light-coloured, moving spots" to which reference is made by Messrs. Wells and Gregory and other authors who might be quoted.

E. Lloyd Jones.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In your April issue Mr. Lloyd Jones says that in a book by Mr. H. G. Wells and myself, "Honours Physiography" (1893), "it is stated that Mars possesses dark clouds which are visible in the large telescopes as dark moving patches." I have pointed out to Mr. Jones that no statement as to "dark" cloud markings is made in the book, and I should be glad if you would make this disclaimer known. What is said is that "Cloud-like markings have been seen to obscure for a time the markings on the face of Mars." Mention is also made of Prof. W. H. Pickering's conclusion that "Clouds undoubtedly exist upon the planet, differing, however, in some respects from those upon the earth, chiefly as regards their density and whiteness." So far as I am aware, this is all that is said upon the subject in the book mentioned. R. A. GREGORY.

Wandsworth, S.W.

Notices of Books.

"THE PRINCIPLES OF MAGNETISM AND ELECTRICITY." An Elementary Text book. By P. L. Gray, B.Sc. (Methuen.) 3s. 6d.—Several minor inaccuracies and laboured expressions have been allowed to remain in this book, otherwise we should have no hesitation in speaking of it in terms of unqualified praise. In the preface we read "The nomenclature of the science is largely derived from a period when unwarranted and probably erroneous ideas as to the nature of electricity were held," and this scientific attitude is maintained throughout, save in one or two notable instances. In speaking of magnets and magnetism, p. 1, Mr Gray says,—"It was the discovery in some dim unknown former time," and three lines lower, "discovered at some unknown remote period." In a future edition the first two chapters should be re-written, for the remarks upon lines of force are not clear, and why should the student naturally assume the law of inverse squares to govern the strength of field at any point? Anyhow, the assumption is made; then, to our astonishment, we find on the next page, "We have also seen that it depends on the square of strengths." In Fig. 9 we see iron filings about the centre of the bar magnet. Chapter IV., dealing with the electric field, is good, but we are surprised at finding the coulomb defined as being 3×10^9 C.G.S. units. The coulomb is, of course, 10^{-1} absolute units of quantity. However, as someone remarked recently, it is absurd that we should have two units, one three thousand millions times as large as the other. A good description of the plate machine is given, but we note a slight inaccuracy in Fig. 38, the handle being wrongly placed. It would perhaps have been as well had the preliminary notions of potential, as also the water analogy, been introduced before this. The description and theory of the quadrant electrometer forms perhaps the best written portion of the book, but we are sorry to find that the author does not keep clearly before his readers that potential difference is not the same thing as electro-motive force. The remainder of the book is to be commended. We have, inter alia, chapters on Alternating Currents, The Discharge, Atmospheric Electricity, etc. The index is a very full one.

"WHAT IS HEAT? AND WHAT IS ELECTRICITY?" By Frederick Hovenden, F.L.S., F.G.S., F.R.M.S. (Chapman & Hall.) Illustrated. 6s.—The two conundrums on the title page of this book are but the precursors of a series with which the work is filled. Very little space is devoted to the giving of answers, and, we regret to say, that of the few answers given not all are accurate. "The solution," says our author, "of these two fundamental problems is placed in the hands of the physicists." From this he argues that the whole matter is treated by metaphysicians, since physicists use mathematics. Next, a heavy frontal attack is made upon the existing system of mathematics.—"All mathematical operations are functions of objects or actions": "any number, per se, is meaningless." And later, "What is an object?" "Take a table." We must not, mathematically, according to Mr. Hovenden, speak of one table, because the table is made up of parts. The parts are of wood, and the wood contains cells made up of atoms. So the only possible unit is the atom. The mathematician, we are reminded, has no power to divide the atom, so, he has no right to speak of fractions. Having thus given the quietus to believers in simple arithmetic, it is naturally time that algebraic ideas should be abolished. "That part of space which has gained is +, and that part which has lost is −. Hence we obtain, as it were, a natural equation +1 = −1." What is to be said of such reasoning? There is, however, worse to come, and, as the error led up to is one likely to be troublesome, it may not be out of place if we take it upon ourselves to answer Mr. Hovenden in detail on this one point. On p. 15, then, objection is raised to the algebraic law which makes the product −100 into −100 equal to +10,000—though, logically, Mr. Hovenden has no right to object, since he has but just enunciated his own "natural equation"). We read,—"See if we can realise this idea. We will take two bowls, and mark one A, and the other B. In the bowl A are 100 objects. We take the hundred objects out of the bowl A, and put them in bowl B. That is mathematically expressed, bowl A −100; B +100. Now multiply the contents of bowl A (−100) by −100 times, and then, says the mathematician, there are ten thousand objects in that bowl!" It is upon such reasoning as this that our author strives in his next sentences to be sarcastic at the expense of the mathematician. But here are his mistakes. A contains a hundred marbles he tells us, these are removed to B. Therefore, A now contains 0 marbles (not −100 as he absurdly suggests). If he will now perform his operation negatively, 100 times over (that is, take 100 times 100 marbles from B to A), he will certainly find that A contains 10,000 marbles. But, so far, we have only arrived at p. 14, and here we propose to pause, for this reason—on p. 7 of his book Mr. Hovenden has asked "If the foundations are defective, how about the superstructure?"

"THE ELEMENTS OF THE DIFFERENTIAL AND INTEGRAL CALCULUS." By J. W. A. Young and C. E. Linebarger. Pp. xvii. and 410. (Hirschfeld Bros. 1900.) 10s. 6d. net.—The attention now being given to the calculus in technical schools and other institutions where physical science and its applications occupy a prominent place in the curricula, is a noteworthy development of mathematical instruction. Attempts are sometimes made to show students who have insufficient mathematical knowledge how to apply the notions of the calculus, but the result must be unsatisfactory in the end, and generally leads to confusion. No student can obtain a really useful knowledge of the calculus unless he is prepared to devote a fair amount of time to the study of its principles. But if he will work steadily at acquiring this knowledge, he will find himself eventually in the possession of a most powerful machine, by which innumerable problems can be solved. The functions of the particular case are put into the machine, or the equation to the appropriate curve or surface is taken, and the result can be worked out almost mechanically. As most quantities in nature change or vary according to some continuous law, the differential calculus admits of applications of the widest range of subjects. Though this has, of course, long been recognised, yet the calculus has until recent years been taught and studied more from the point of view of pure mathematics than for its practical value. Now, however, several books are available in which the calculus is expounded "for engineers," "for technical students," "for chemists," and other students of science and technology. One of the first books prepared in this spirit was by Profs. Nernst and Schönflies, of Göttingen, and the present volume is an adaptation of it. The distinguishing characteristic is the continual use of illustrative examples from scientific data, and nothing but praise can be said for the introduction of this method. The German work was intended primarily for chemists, and a large number of the examples are drawn from physical chemistry. But as a matter of fact, there is very little that is specially chemical in this book, and although this shows that mathematical chemistry is still in a rudimentary stage, it also adds to the value of the volume to students who are not chemists. The book opens with a chapter on analytical geometry. As students beginning the study of the calculus do not possess usually the power of graphing even the simplest functions, this introduction is essential. After it the chapters deal successively and respectively with limits, fundamental conceptions of the differential calculus, derivatives of the simpler functions, fundamental conceptions of the integral calculus, simple methods of integration, some applications of the integral calculus, definite integrals, higher derivatives and functions of several variables, infinite series, maxima and minima, and differentiation and integration of functions found empirically. While we do not consider that the book contains an ideal course of work upon the calculus, yet it is highly to be praised, and should prove of real value to all serious students of the physical sciences.

STANDARD SILVER: ITS HISTORY PROPERTIES AND USES.—II.

By ERNEST A. SMITH, ASSOC.R.S.M., F.C.S.

ALTHOUGH sterling silver was used in England for the manufacture of plate at a very early period, "the Anglo-Saxons being always reckoned skilful in the use of gold and silver," the first statute made for regulating the standard of silver to be used by workers in this metal in England is that of the 28th Edward I., c. 20 (A.D. 1300). It ordains that goldsmiths shall make no worse silver than "silver of the sterling alloy of the coin, or better at the pleasure of him to whom the work belongeth" (argent del alloy de le esterling ou de meilleur), and that none work worse silver than money.*

From the table given last month it will be seen that the standard for coinage was altered several times during the interval from the 34th of Henry VIII. (A.D. 1542) to the 6th of Edward VI. (A.D. 1552), but the silver used for plate made during this period appears to have remained "as good as the old standard 925; and was not debased like the coin of that period."†

In consequence, however, of the adoption by silversmiths of the practice of melting the coin of the realm to convert it into plate, legislation for the protection of the coin became necessary in the reign of William the Third.

The extent to which the practice of manufacturing plate from the coinage was carried was largely due to the fact that in the reign of James the Second immense quantities of plate had been sacrificed for the use of the King and of Parliament by converting it into money, and that now the opulent gentry were desirous of replenishing their side-boards and tables with plate. The melting of the coin of the realm was, therefore, adopted by the silversmiths as the most expeditious way of obtaining silver "as good as sterling."

In order to prevent this wholesale conversion of coin into plate an Act was passed which raised the legal standard for silver plate above the standard of the coinage, thus rendering the latter less available to the silversmith.

The Act of Parliament (A.D. 1697-8, William III., c. 8, 5, 9) relating to the new standard states that "it might reasonably be suspected that part of the silver coins of the realm had been, by persons regarding their own private gain more than public good, molten and converted into vessels of silver or other manufactured plate, which crime had been the more easily perpetrated by them, in regard the goldsmiths or others, workers of plate, by the former laws and statutes of the realm were not obliged to make their plate of finer silver than the sterling or standard ordained for the monies of the realm." It was therefore enacted that, from March, 1697, no silver plate should be made of less fineness than that of 11 ozs. 10 dwts. of fine silver in every pound troy (or 959 parts of silver per thousand), and that no silver vessels, etc., made after that time, should be put to sale until they had been Hall marked.

In order to distinguish plate of this new standard it was appointed that it should be marked with the "figure of a woman commonly called Britannia."

On account of the softer nature of the new standard, due to the larger percentage of silver present in it, it was found that articles made of this alloy were not so serviceable nor so durable as those made of the old standard.

Copper being a harder metal than silver the relative abrasion suffered by alloys of silver and copper is dependent on the percentage of copper present.

By an Act of Parliament, the 6th of George I., c. 2, ss. 1 and 41 (A.D. 1719), the old standard of 11 ozs. 2 dwts. (925) was revived concurrently with that of 11 ozs. 10 dwts. (959), and these two standards still exist for plate, though only the former is in general use.

The standard 925 is always spoken of as the "old silver standard of England," while the standard 959, although seldom used, is referred to as the "new silver standard," or sometimes as the "Britannia" standard, owing to the fact that silver wares of this standard, as stated above, are marked with the figure of "Britannia," when sent to the Assay Office to be Hall marked.

The silver standards used in other countries are also fixed by law, and it is of interest to compare these with the English silver standards. In the subjoined table the standards of fineness of silver used for coin and for plate in other countries are given.

TABLE showing the Silver Standards for Coin and for Plate of the Principal Countries of the World.*

Country	Coins: Fine Silver per lb. Troy. ozs.	dwt.	Coins: Fine Silver per 1000 parts.	Plate: Fine Silver per lb. Troy. ozs.	dwt.	Plate: Fine Silver per 1000 parts.
America	10	16	900	No fixed standard		
Austria-Hungary	10	16	900	11	8	950
Austria-Hungary	10	0¼	835	10	16	900
Austria-Hungary	6	4¾	520	9	12	800
Austria-Hungary	6	0	500	9	0	750
Austria-Hungary	4	16	400			—
Belgium	10	16	900	10	16	900
Belgium . .	10	0¼	835	9	12	800
Colonies:—						
Canada, Newfoundland	11	2	925	—		—
Ceylon, Hong Kong, Straits Settlements	9	12	800	-		—
Denmark ...	9	12	800	9	18¼	826
France .	10	16	900	11	8	950
France	10	0¼	835	9	12	800
Germany	10	16	900	9	12	800
Holland	11	7	945	11	4	934
Holland . .	—		—	10	0	833
India (British) ...	10	19	916·6	—		—
Italy	10	16	900	11	8	950
Italy	—		—	10	16	900
Italy...	—		—	9	12	800
Japan	10	16	900	—		-
Japan . .	9	12	800	—		—
Norway and Sweden	9	12	800	9	18¾	828·1
Norway and Sweden	7	4¼	600	—		—
Portugal .	10	19	916·6	10	19	916·6
Portugal ...			-	10	0	833
Portugal	—		—	9	12	800 for export
Russia	10	16	900	10	18¼	910
Russia	10	8	868	10	11¼	880
Russia	6	0	500	10	1·5	840
Spain	10	16	900	10	19	916·6
Spain ..			—	9	0	750
Switzerland ...	10	16	900	10	10	875
Switzerland ..			-	9	12	800
Turkey ..	10	16	900	10	16	900
Turkey . ..	9	19	830	-		-
United Kingdom	11	2	925	11	2	925
United Kingdom ...	—		—	11	10	959

Compiled from Parliamentary Return relating to Gold and Silver Marking in Foreign Countries, February 21th, 1890, and from other Sources.

It will be evident from the above table that the standard 900 is now more widely used than any other, England alone employing 925, that is, 11 ozs. 2 dwts. per ounce troy, thus maintaining the connection with Saxon coins.

As previously stated, the silver standard of this country has from very early times been computed by divisions of the troy pound. The adoption of the metric system of weights and measures in most other countries no doubt accounts for the use of alloys of decimal proportions in these countries. Alloys of lower

* Chaffers, "Hall Marks on Plate," 8th edit., 1896, p. 6.

† *Idem*, page 10.

standard have an advantage over those of higher standard, inasmuch as the abrasion suffered by an alloy with 90 per cent. of silver would be less than that suffered by an alloy containing 92.5 per cent. As silver and copper are capable of uniting in all proportions by direct fusion, standard silver is prepared by melting together the requisite quantities of the two metals. The fusion is usually effected in plumbago crucibles, those in use at the Royal Mint having a capacity of 4000 ounces.

Alloys of these metals possess the characteristic pure metallic whiteness of silver until the copper amounts to 50 per cent. of the alloy, and the tint becomes more and more red with the increase in the amount of copper above this limit. The effect of copper is to increase the hardness and elasticity of the alloy, hence silver is always alloyed with copper to obtain the hardness required to enable it to withstand the wear to which coins, etc., are subjected; pure silver, as previously stated, being too soft for the purpose. The hardest alloy of these metals consists of about $31\frac{1}{4}$ per cent. of silver and $68\frac{3}{4}$ per cent. of copper, or a ratio of 5 to 11.

Although the products of the fusion of silver-copper alloys in any proportions are comparatively homogeneous, yet it has long been remarked that ingots of alloys of these metals are not absolutely identical in composition throughout.

Considering that silver-copper alloys of various composition have long been used universally for the purposes of coinage and plate, it is not surprising that this series of alloys has been the subject of careful experiment, and much is now known respecting them. Recent research has shown that one of the most interesting facts connected with them is the remarkable molecular rearrangement they undergo during solidification.

Levol, who is one of the chief authorities on the subject, concluded that the only homogeneous alloy of the series contains 71.89 per cent. of silver and 28.11 per cent. of copper; and he considers this alloy to be a definite compound of the two metals having the formula Ag_3Cu_2. All other alloys of silver and copper Levol regarded as mixtures of this definite alloy with excess of either of the metals.

His experiments showed that in alloys containing more than 71.89 per cent. of silver the centre of the solidified mass is richer in silver than the exterior, while in alloys of lower fineness than this the centre contains less silver than the external portions.‡

Sir Roberts-Austen repeated many of Levol's experiments, and concluded§ that uniformity in composition of the series of silver-copper alloys depends greatly on the method of cooling. By slow cooling many alloys other than the one mentioned above may be made as uniform as it, its peculiarity consisting in the fact that its composition is uniform whether it is cooled slowly or rapidly.

With regard to the homogeneity of English standard silver (925) cast under ordinary conditions, it appears from a long series of experiments made some years ago by Col. Smith for the Indian Mints|| that the tendency of the silver and copper to separate depends upon the inequality of the rate of cooling in the different parts of the ingot. The act of cooling causes a partial separation or liquation of the copper towards the surfaces which cool first, those parts of the bar being richest in silver which solidify the last.

The researches of Roberts-Austen have shown that the maximum difference in the composition of an alloy containing 925 parts of silver and 75 parts of copper is only 1.40 parts per thousand when the alloy is slowly cooled, while it is as much as 13 parts per thousand when the alloy is rapidly cooled.

The irregularity in the composition of standard silver due to liquation is a matter of great importance in mints where the production of alloys of uniform composition is very desirable.

With suitable moulds and uniformity of cooling liquation may be almost entirely prevented, but unless great care is exercised in the preparation and casting of the alloy the irregularities in the composition will be much greater than those quoted above.

In establishments where standard silver is prepared for trade purposes and is subsequently manufactured into goods to be Hall marked it is the common practice when preparing the alloy to add a little extra pure silver beyond the quantity actually required. This is done in order to overcome the irregularities in composition due to liquation, and to obtain an alloy which will be a little above the standard in all parts and thus satisfactorily pass the Hall.

Standard silver, apart from its attractive appearance, possesses many properties which render it valuable in industrial art. It is very malleable and ductile, and can be readily rolled into thin sheets and drawn into very fine wire. It possesses a brilliant metallic lustre and is capable of taking a high polish. One of its most valuable properties is the readiness with which it may be made to "flow" under pressure. It is well known that "when a malleable metal or alloy is extended by mechanical processes, such as rolling, stamping, or hammering, a true flow of the particles of the metal occurs, analogous in all respects to the flow of viscous fluids. The pressure exerted upon the surface of the metal is transmitted in the interior of the mass from particle to particle, and tends to produce a flow in the direction where the resistance is least."¶

The application of this fact, that solid metals and alloys flow like viscous fluids, is of great importance in industrial art, and the production of various complicated and artistic forms with standard silver by stamping, spinning, chasing, etc., entirely depends on the flow of the metal when suitably guided by the artificer.

The striking of coins presents a familiar instance of this valuable property of standard silver, the metal, under pressure, being made to flow into the sunken portions of the die without fracturing, thus producing a true impression with every detail clearly defined. The stamping of knife handles and small trays also affords a familiar example of this property. The art of stamping and shaping articles of jewellery, etc., in a press from sheets of standard silver came into general use just previous to the first Exhibition of 1851, and a very large quantity of work is now produced by this means.

During the mechanical processes, such as hammering and stamping, the metal becomes more or less hard and brittle, and requires to be annealed at frequent intervals. This is effected by heating the metal to a dull red heat in a non-oxidising atmosphere, whereby its original softness is restored.

‡ *Ann. de Chim. et de Phys.*, Vol. 36 (1852), p. 193; Vol. 39 (1853), p. 163.

§ *Proc. Roy. Soc.* Vol. XXIII. (1875), p. 481.

|| *Idem*, p. 133.

¶ Percy, "Metallurgy," Vol. I., page 22.

By the application of certain processes the surface of standard silver may be made to assume various tints, by which means the artistic effect is increased.

When silver-copper alloys are heated to dull redness, with access of air, the surface becomes blackened, owing to the formation of a film of copper oxide, but by blanching—that is, immersion in hot dilute sulphuric acid—the copper oxide is dissolved, and the silver assumes a beautiful dead-white appearance known as "frosted" silver.

When silver articles have been thus frosted and the portions in relief are burnished, very effective results are often obtained, and the beauty of the ware greatly enhanced.

Articles of plate may be "frosted," or, as it is sometimes termed, "matted or deadened," also by boiling them in bisulphate of potash, which acts in the same way as dilute sulphuric acid.

In order to obtain on ornamental silver wares the effect known as oxidized silver, the surface is darkened by a thin film of silver sulphide, produced by boiling the articles in an aqueous solution of potassium sulphide, and then rubbing with very fine pumice, which removes the dark layer of silver sulphide from the portions in high relief and leaves dark lines in the more deeply-cut recesses.

The effect thus produced is frequently very striking, and adds materially to the appearance of the article.

At the Paris and London Mintsº silver medals have recently been subjected to the process known as "sand blasting," by the aid of an appliance which projects against the surface of the medal a small jet of air carrying with it fine sand, and having a velocity of about 180 feet per second. When thus treated, the surface of the medal becomes "frosted," and may be subsequently oxidized as above described, or the following process may be adopted. The "frosted" medal is immersed in an alcoholic solution of platinum chloride, whereby the surface becomes blackened by the deposition of a thin film of metallic platinum. Subsequent rubbing with a brush and very fine pumice changes the blackened surface to a delicate grey, and if this operation is conducted skilfully, graduated shadows may be left wherever the artist considers their presence to be desirable. The beauty of the medals so treated, and the fidelity with which the details of the design are revealed, is beyond question, but it may be doubted whether the surface of the medal is permanently protected.

(To be concluded.)

** 28th Report of Royal Mint, 1897, p. 17.

THE WHITE NILE—FROM KHARTOUM TO KAWA.

AN ORNITHOLOGIST'S EXPERIENCES IN THE SOUDAN.

By Harry F. Witherby, F.Z.S., M.B.O.U.

II.—THE RIVER—ESSENTIAL ALIKE TO MAN, BEAST AND BIRD.

Having obtained all the necessary permits as well as baggage and riding animals, our next task was to engage servants. We eventually gathered together a motley and somewhat amusing crowd. The chief of these—one Hassan Mahomet Eshari, an Egyptian—we brought from Cairo, and he proved in every way an excellent interpreter and hard-working headman and servant. Mustapha, who hailed from Berber, was a cook as well as a lazy and perfidious rascal. Mahomet, an old kingly-looking Turk, whose ankles were callous through the shackles of the Khalifa, was as useful as to the donkeys. He was a fine figure, and generally rode in front of our caravan, ordering the natives out of the path, or commanding them to come and show the way for a mile or two, all in a most dignified manner. But when it came to work in camp his one idea was to sit on his haunches and smoke, and to obtain the services of the nearest wandering boy to wait upon him and his donkeys. The natives feared him much, and generally obeyed him without a murmur, but all our hard sayings and harder doings failed to make much permanent improvement in his habits.

We had great expectations of Mirsal, an old Soudanese soldier, who was to act as a gun-bearer. When I engaged him he went through a most charming pantomime. Gripping his right arm with his left hand, he swore by the Prophet's beard that so long as there was strength in that arm he was my most faithful servant. A few days later, when on the march, we sent him over to a village on the other side of the river with money to buy food and tobacco. We never saw him again, nor could policemen mounted on camels find him. But maybe we misjudged him. The strength may have forsaken his arm. Our camel men were from Dongola. They were a lively, irresponsible crew, requiring much physical persuasion. On the whole, we were not greatly impressed by the reliability of the natives of the Soudan, as far as concerns either work or honesty.

Our final plan was to travel up the river quickly, and to return slowly. While marching up the river we, of course, should have no time for collecting or preserving, but we should be able to make notes of the birds and the country, and thus obtain a knowledge of the ground which would greatly assist us on our return in deciding where to make collecting camps, and how long to stay at each.

Mahomet at Work.
From a photograph by Mr. C. F. Camburn.

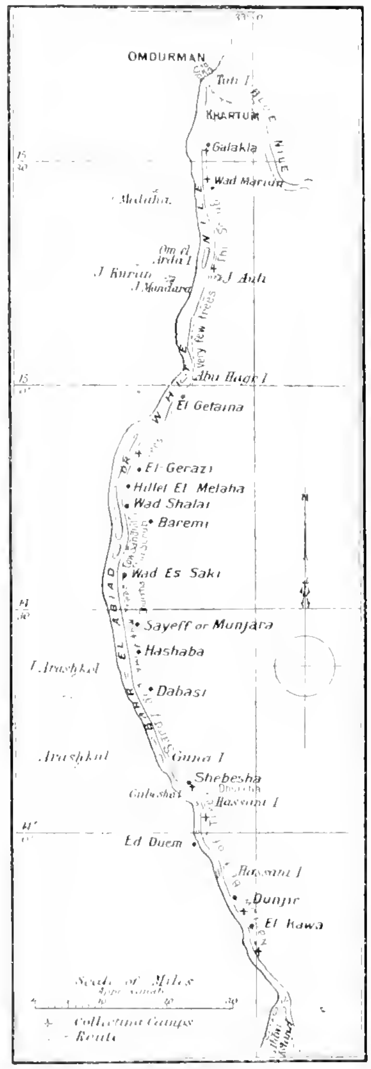
With much kind help from many in authority at Omdurman all our preparations were at last complete, and on the afternoon of March 20th, we sent our men, animals, and baggage across the White Nile to the Khartoum, or east, bank. Joining them early the next morning we found to our great relief that there were no deserters, and, moreover, that all disputes as to which box or package should be carried on which camel were settled, and all were ready to start. The apportionment of loads and the loading up at the start are always difficulties, and never before had we experienced so little trouble.

It is remarkable how regular a stride and how even a pace the baggage camel will keep up hour after hour. Two and a half miles an hour is his pace, and twenty miles is for him a good day's journey. As the camels carried our food, tents, beds, and indeed all our baggage, we had to arrange our day's march according to theirs, our procedure being generally as follows. Rising just before the sun (about 5 o'clock) we breakfasted, struck tents, packed up and got away about seven, marched for five hours, then rested during the heat of the day, and marched again for some two or three hours in the afternoon, getting into camp as the sun was going down about 6.30. We travelled thus to a point some ten miles south of a town named Kawa, on the east bank of the White Nile, about 150 miles south of Khartoum, and there we stopped and made our first collecting camp.

A reference to the accompanying sketch map will give an idea of our route. We marched as a rule close along the river, which was in many ways more convenient and pleasant than the desert track. At high Nile the route by the river is impossible, as much of the land is then flooded, and long detours here and there are necessary to avoid the "Khors" (equivalent to the South African "dongas"), some of which during the rains are often impassable torrents, whereas in the hot season they are merely dry watercourses. Often we rode for miles along the narrow strip of short grass which in places grows by the river, but now and again this pleasant going gave way to soft sand which was trying for the donkeys, and, if a heavy wind was blowing, disagreeable for us. But more annoying still, and more frequent, were the wide stretches of mud covered by the river during its flood, but now hard, caked and cracked in every direction by the powerful sun. So large and deep were these cracks, and so numerous, that our donkeys continually got their legs into them, the result often being a sudden collapse of the beast and the discomfiture of the rider, while sometimes a donkey's legs became so firmly fixed in a crack that it required our united efforts to lift him out again. After due experience of this method of travelling we avoided the wider stretches of mud by turning off into the desert track, which although hot and dusty, was at all events firm.

One does not need to travel far up the White Nile in the dry season to be impressed by the glaring fact that the life of every man, beast and bird in the country is entirely dependent upon the river. Beasts such as camels and even goats can be gradually trained to exist without water for as long as two or three days, but man cannot live long in this burning country without the life-giving water, as many a poor wretch has proved, while birds are even more dependent upon it. There is no dew, and save for a small well here and there at long intervals, water can only be had at the river. Man, or rather woman for him, has to come there to get his water, and thither he has to drive his camels, cattle and goats, often from long distances, to drink.

To the river every morning and evening, as regular as clockwork, flock after flock of sand-grouse and pigeons come down to drink. All day long small birds are passing to and from the trees and bushes to the river's edge, while at dawn or in the evening, wild beasts of many kinds come from their haunts on the same errand. But man is dependent upon the river not only for the water he drinks, but largely also for his food. It is true that much "dhura," the corn of the country, is grown during the rainy season out of reach of the Nile even at its greatest height, but by far the larger part and the richer part of the cultivatable land is the mud which so troubled our donkeys, and this mud is entirely dependent upon the flooding of the river to render it fit for agriculture. The same may be said of the islands in the river, which are covered at high Nile, and afterwards prove of the utmost value for cultivation. So rich is the land on these islands that even the lazy Soudanese find it worth their while further to utilize the river by raising the water with the "shadoof," and so continue cultivation during the dry season. At the time of our journey these islands were almost the only green spots in a wilderness of brown and sun-scorched land. At long intervals only, did one or two "shadoofs" keep green some small patches of onions, water melons or beans on the mainland.

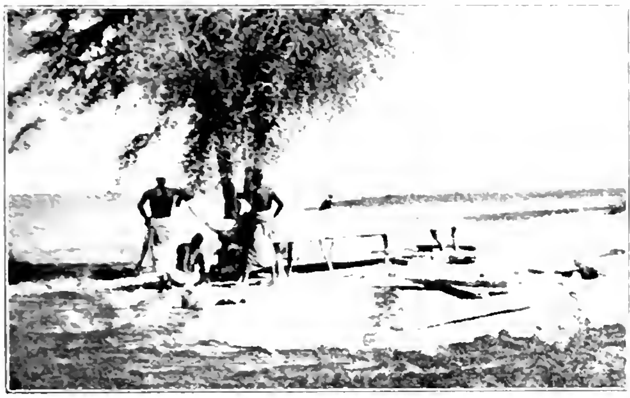


Sketch Map, showing route and collecting camps.

As a highway, the river is extremely valuable. Sailing boats of various kinds—gyassas, feluccas, nuggars and even dahabiehs—are continually travelling up and down laden with corn and other produce, while rafts of all sizes are numerous. The timber forming a raft is generally of the "sont" tree, a species of acacia, and is cut by a few natives who join together for the purpose. When the wood is cut and floated, and the raft completed, they thrust it out into the river, and are then entirely at the mercy of the current, which flows some one or two miles an hour in the dry season. These men make their home on the raft, protecting themselves from the sun by improvising awnings of the cloths which they wrap round their bodies at night. Eventually the current carries them to Omdurman, where they get a good price for the wood as fuel, which is exceedingly scarce near the town.

Besides the sailing boats and rafts, steamers ply up and down the White Nile at least three times a month, to carry passengers, and to take rations and other things to the troops stationed at various points. Now that a channel has been cut through the Sudd on the upper White Nile the river is navigable for 1000 miles south of Khartoum. From Cairo to Khartoum is some 1500 miles by river. Some day when channels have been cut through the cataracts, by no means a very remote probability it will be possible to steam 2500 miles up this wonderful river at all times of the year.

The wild life in the river and along its banks was a continual source of pleasure to us as we rode along. Hippopotami were rarely seen, but now and again an enormous black head would show above the water for



Boatbuilding on the White Nile.
From a Photograph by Mr. C. F. Camburn.

a few moments, and sometimes a long black ridge in the middle of the river would denote where a hippo was resting on some sandbank barely covered by the water. We often saw gigantic footprints on the bank, where one of them had come out of the water to feed, and at night the natives light fires at intervals along the river side to keep the great beasts in the water, for a patch of beans is little to boast about after even one hippopotamus has been browsing in it.

Much further south than we travelled the hippo is exceedingly common, and notwithstanding the restrictions, many must be killed if one may judge by the universal use of the "Korbag," a whip which is made out of its hide. It is curious how this whip, which, by the way, we found very useful for both man and beast, is employed under various names (such as "sjambok" in the south) all over Africa. Crocodiles were common and were often to be seen, sometimes three or four together, lying asleep on the bank, facing the breeze with their mouths wide open. Once we saw two calves standing unprotected at the water's edge, and just as we passed, the ugly head of a crocodile appeared within ten yards of them, but it slowly drew back on seeing us. As a rule the natives make a ring of thorn bushes in the river where they water their goats and cattle to protect them from the crocodiles. But they seem to have no fear of the reptiles for themselves. They wade out into the river to fetch water; if a boat sticks on a sandbank the crew jump out without hesitation; and, more remarkable still, fishermen may often be seen standing motionless up to their shoulders in the water while fishing with nets. The natives are very fond of the flesh of the crocodile, and once when I had shot, but failed to kill, one of the reptiles, our camel men threw off their clothes and rushed into the river in the hope of "tailing" it. It is true that the men were hungry at the time, having squandered their money upon "merissa" or "boozer," and having had little to eat for some time with the exception of a large fishing eagle, which they had consumed with avidity some hour or two after it had been shot. A specimen of this eagle, the vociferous sea-eagle,* may be seen at the Zoological Gardens in London. With its white hood it is a conspicuous object, and a fine looking bird when perched upon some tree or on some snag in the river; but near at hand it is dirty and disappointing looking, and to my taste decidedly unappetising.

Other birds** abounded in the river and on its banks. Nile geese† were numerous, but very wary. The white man shoots at them with every sort of weapon at every sort of range, for their flesh is good; and the natives with shouts and sticks and stones worry them out of their bean crops. Another much handsomer and larger goose, the spur-winged goose,‡ was rarer, and so cautious that we were never able to shoot a specimen. Cranes, storks, ibises, and herons of various kinds were generally

A Midday Halt.
From a photograph by Mr. C. F. Camburn.

in sight wading in shallow water or stalking about on the short grass by the river. We sometimes passed within a few yards of a group of crowned cranes,§ with their rich colouring of black, white, and chestnut, and their curious tufts of golden grass-like feathers, and at one camp a confiding old bird used regularly to roost on the top of a tree near our tents until he was added to our collection. The sacred ibis,|| celebrated by having been much mummified, and by its many portraits upon the tombs and temples of ancient Egypt, was most confiding. This bird only visits Egypt during the period of inundation, and consequently very few travellers in that country see it, the buff-backed heron being made to do duty for it by the tourists' dragoman. However, the real thing is totally unlike the substitute. Its jet black head and neck, which are bare of any feathers, and its black legs, serve to accentuate the pure white plumage of its body, while its wings are edged with black like a mourning envelope, and from each shoulder droop green-black feathery plumes. When flying towards one the bird seems to be streaked with blood, for the wing-bones are bare of feathers on the under side, and the skin which covers them is of a rich vermilion colour. At intervals along the river were beds of shell fish (Aetheria) like oysters. The Nile fell so low in 1900 that a great many of these "oysters" were left high and dry, and were consequently decomposing. Yet numbers of wading birds frequented the beds, and

* *Haliaëtus vocifer*, Daud.

** For a full account of the birds collected and observed during the expedition see the *Ibis*, April, 1901, pp. 237-278.

† *Chenalopex ægyptiacus*, Briss.

‡ *Plectropterus ruppelli*, Sclat.

§ *Balearica pavonina*, Linn.

|| *Ibis æthiopica*, Lath.

amongst them none were more conspicuous than the Marabou storks,* the African representative of the adjutant of India. Not only were they conspicuous by their size and form, but their dull-looking plumage, their bare reddish-yellow heads, and their enormous dirty bills, gave them a most revolting appearance. They are carrion feeders, and seeing them smash open the oyster shells with their massive and powerful bills one could well understand how it was that after the battle of Om Debreikat many a man, well accustomed to gruesome spectacles, shuddered at the sight of corpses mutilated by these birds. Another interesting member of the stork family which frequented the "oyster" beds was a sombre coloured bird with a thick whitish bill, the mandibles of which are so grooved near their tips, that an open slit is left when the bill is closed, a peculiarity which has given the bird the name of open-bill.** Of the many other birds frequenting the river the pelicans†† were, perhaps, the most striking. One evening as we urged our mounts over the brow of a small sandhill we came suddenly in sight of a great flock of these birds in the shallow water at the river's edge. Some were dozing, others were preening their rose-white plumage, others were dabbling their clumsy-looking bills in the water and washing their yellow pouches, while over the whole flock the setting sun threw a delicate rosy hue.

For so large and heavy a bird the flight of the pelican struck me as being peculiarly graceful. A few powerful flaps are given as the bird rises slowly off the water, then the wings are outstretched and it skims straight and swiftly along within a foot of the surface for some hundred yards, then curving slightly upwards, it flaps its wings again and is prepared for another long floating flight.

Before leaving the river and its attractive birds, the black-headed plover,‡‡ or courser, a bird somewhat smaller than the golden plover, deserves mention if only on account of the interesting and historical habits accredited to it. There can be little doubt that this bird is the "τροχίλος" of Herodotus, who ascribed to it the habit of attending crocodiles, and of feeding in their open mouths. At least two naturalists in modern times have actually observed the bird thus act. Some ornithologists, however, are disinclined to believe that it does really enter the crocodile's mouth, and suggest that when a crocodile is lying with its mouth wide open, a bird running about on the sand behind the mouth would appear at a little distance to be actually between the reptile's jaws. However this may be it seems a pity now to discredit a habit which has made the "crocodile bird" a celebrity for so long a time. I am sorry to be unable to give any evidence on the subject. The bird was very common along the banks of the White Nile, and we much admired its rapid and graceful actions and its beautiful plumage of delicate blue-grey marked with white and black, but we never saw it near enough to a crocodile even to suspect it of engaging in the laborious and risky task of picking the reptile's numerous and merciless teeth.

* *Leptoptilus crumeniferus*, Cuv.

** *Anastomus lamelligerus*, Temm.

†† *Pelecanus onocrotalus*, Linn.

‡‡ *Pluvianus ægyptius*, Linn.

Note.—It should have been stated in my first article (Knowledge, April, 1901) that the photographs from which it was illustrated were taken by Mr. C. F. Camburn, one of the taxidermists who accompanied me on the expedition.

British Ornithological Notes.

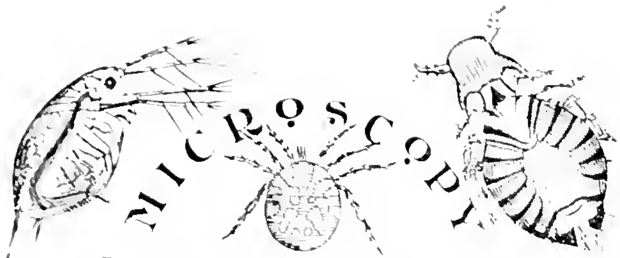
Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Early Appearance of the Nightjar in Hampshire.—On May 5th I put up a Nightjar near Burley, in the New Forest. As is well known, the bird rarely arrives in England before the middle of May, and the 5th of the month is undoubtedly an unusually early date for its appearance. Judging from the experience of several correspondents as well as from my own, the bulk of the migrants have arrived this spring at their usual dates. The late spring in this country could of course have no influence on birds coming from a distance, but the season has been cold and backward, seemingly, in the south of Europe, and it is surprising what little influence this has upon the regularity of the return of our summer migrants.—Harry F. Witherby.

Mimicry by the Butcherbird.—It has been said that the Great Grey Shrike imitates other birds for the purpose of attracting them within range of attack (Yarrell, British Birds; Ed. 4, Vol. I., p. 201). Yarrell noticed that the Red-backed Shrike or Butcherbird has a note like that of the Housesparrow. In "The Evolution of Birdsong," I suggested that this note might be the loud "chell" or "tell" of alarm given by the Butcherbird, and which is somewhat similar to a note of the Sparrow. On the 5th of May, however, I obtained evidence supporting the idea of voluntary mimicry on the part of this bird. In company with Mr. A. E. W. Paine, of Swords House, Leddington, Ledbury (a life-long observer of birds), I was cycling across some open land, and saw within ten yards of the road a Butcherbird on a post, evidently singing. The bird seemed to fear no harm from cyclists, and continued its song while we passed. We both heard it give in its warble very distinctly the "twink" or "pink" of the Chaffinch. A thick hedge commenced at the spot, and in the shelter of it we dismounted and listened to the curious babbling song of the bird, and heard it utter some notes closely like those given by a Sparrow when singing. One feature of the song (and I heard the same in a captive Butcherbird) was the alternation of soft and loud passages in one strain. A minute later a noisy cart rapidly passing scared the bird to a distance, where he began to feed. I watched him for some time through a telescope. No other birds were near, except a few Sand Martins.—Charles A. Witchell, Charlton Kings, Cheltenham.

Arrival of Swallows.—I can report the sight of my first Swallows this year, on April 8th. The dates for seven years past on which I have first seen Swallows here are as follow:—1895, April 10th; 1896, April 12th; 1897, April 7th; 1898, March 14th; 1899, March 29th; 1900, April 15th; and 1901, April 8th. I saw the first Swifts this year on April 19th.—E. Sillence, Romsey.

Ornithological Notes from Norfolk for 1900. By J. H. Gurney, F.Z.S. (*Zoologist*, April, 1901, pp. 121-140). For many years Mr. Gurney has contributed to the pages of our contemporary a useful and interesting record of the ornithological events occurring during the year in Norfolk. As far as rarities were concerned, 1900 was uneventful. At the beginning of January a good many Bitterns were reported. During February and March a very large number of Little Auks were washed up on the East Coast. In 1895, it will be remembered, there was a similar incursion all along our eastern seaboard, but in 1900 the birds seem to have kept more together, and most of them perished in Norfolk. Previously recorded irruptions of the Little Auk in Norfolk have occurred in October, 1841; December, 1848; November, 1861. It is satisfactory to learn that Spoonbills continue regularly to visit Norfolk in slightly increasing numbers. With Mr. Gurney's observation that the Tawny Owl does not leave castings in its nesting hole we cannot agree, having repeatedly found the reverse the case.



Conducted by M. I. Cross.

Fine Adjustments.—In the details of the construction of microscopes, as in fact in every other instrument or machine, there is no real finality, and each year sees the introduction of some slight improvement which may tend to make work easier and more accurate. A study of the catalogues of the various microscope manufacturers of a year or two ago will afford food for reflection, for nearly every noted maker then expressed his unbounded confidence in his particular form of fine adjustment. One states that his "must be considered to be a triumph of mechanical skill," another "has proved absolutely satisfactory," and a third "its reliability is unsurpassed." Yet within the space of a few months nearly all the leading makers found it desirable to introduce new devices for fine adjustments. All of them have distinctive features, indicating that care and consideration have been given to their design, and it will probably prove of interest to readers to be made acquainted with such particulars as I have been able to collect from the various makers, for every new idea which enables the worker to manipulate more precisely than available means have permitted him formerly to do, should receive both consideration and recommendation.

A perusal of the paper read before the Royal Microscopical Society, by Mr. E. M. Nelson, and reported in the Society's *Journal* for August, 1899, on the "Evolution of the Fine Adjustment," conveys some idea of the gradual improvement that has taken place in that movement.

Those who use a substage condenser giving a small aplanatic cone will probably not feel the necessity of a better fine adjustment than that which is usually fitted to student's stands having the direct pillar action.

Directly an illuminating cone bearing a fair proportion to the numerical aperture of the objective is used, the necessity for a slow and precise movement by fine adjustment becomes overwhelmingly apparent.

In a previous article I referred to the fact that many new substage condensers yielding large cones of illumination had been recently introduced, and as the supply of such articles must indicate a demand, it necessarily follows that people who have used them have discovered the weakness in the fine adjustments of their instruments, have called for something better, and response is being made by manufacturers to meet this fresh demand.

There are four new fine adjustments which I propose to review, as follows:—The Continental pillar fine adjustment with levers, designed by Reichert, of Vienna; the new fine adjustment fitted to their photo-micrographic stand, by Zeiss; the "Ariston," by Swift and Sons; and Stringer's fine adjustment, by W. Watson and Sons.

Reichert's Fine Adjustment.—The great weakness of the Continental pillar form of fine adjustment has been consequent principally on the difficulty of producing a sufficiently slow rate of movement with a direct-acting screw that would stand wear and tear. The problem has been met by Reichert's device, which consists of a screw, having a point which engages two lever arms, the upper pressing upon the lower, and being mounted from the outer sides of the pillar. To the under sides of these levers is attached a piece of hemispherical shaped metal, which has on its curved side a point which communicates the motion.

A reference to the illustration in our next number will make this otherwise obscure description quite clear, and it will be further seen that the [illegible] of movement is diminished by the proportions of the lever arms which are about 2 : 1. This would mean that if a screw of [illegible] and were used, the rate would be reduced to [illegible] for each revolution instead of [illegible] in. as in the old pattern.

(The illustration referred to in the above [illegible] in the July number of Knowledge.)

The Microscope and the Pharmaceutical Chemist.—To the busy medical practitioner, reference to the microscope for diagnostic purposes is a matter of every day occurrence. Those who have not the time or disposition to do the work themselves, have at their disposal associations and laboratories which cater for their special needs. In addition to these facilities, it is becoming usual for pharmaceutical chemists to make themselves acquainted with the wants of medical men in these respects, and to be prepared to make the examinations, and to provide themselves with the necessary modern apparatus for so doing.

The microscope is becoming increasingly important in the curriculum of the pharmaceutical student, and it is in no small degree due to this profession that so much of our food and drugs that once were adulterated, are now purer and of better quality. Powdered drugs and spices were frequently mixed with starches, flour, etc., but the microscope quickly discloses such foreign materials. The knowledge of active constituents and other cell contents of medicinal plants, and their distribution in different tissues and organs is becoming increasingly comprehensive and accurate, and experiments aided by the use of special micro-chemical reagents are in progress to identify the vegetable alkaloids and related substances microscopically.

It is a satisfaction to know that work of so thorough a nature is in progress, and it is a guarantee that with increased and more general expert knowledge, our food, drugs, and other commodities will be purer and finer than they have been.

The Workshops of E. Leitz, Wetzlar.—A correspondent sends a description of his visit to the microscope factory of this noted optician. The following is a short *résumé*:

5000 microscopes per annum is the output of this house, leading one almost breathlessly to ask "What becomes of them all?" Leitz's great feature is that he confines himself entirely to microscopes and their accessories, instead of producing scientific instruments of every description as English opticians generally do. Herein lies the secret of his success.

With a large and regular demand for certain fixed models, a system of production in which machinery plays an important part is possible, and ensures sound construction with a minimum of cost. The supervising and testing departments are of the most thorough description, and when the care that is taken is known, it is not to be wondered at that the Leitz objectives are credited with being more uniform in quality than any others.

It has many times been stated that the reason why Continental houses produce cheaply is because they employ women workers. Leitz has no female labour at all; all his men are skilled mechanics, the majority of whom have been trained in the works.

It is quite possible for English houses to compete successfully with foreign competitors if they do but adopt their methods, which may be summarised in a few words. Have the works in a country town where rents are low, and the cost of living less than in London. Have suitable buildings for workshops, and the rest is a matter of system and machinery.

NOTES AND QUERIES.

H. Davy.—The two books that are likely to give you the information you require are "A Popular Handbook to the Microscope," by Lewis Wright, price 2s. 6d., and "Modern Microscopy," by Cross and Cole, price 3s. 6d. More costly works are "The Microscope," by Hogg, new edition, price 10s. 6d., and "The Microscope and its revelations," by Carpenter, edited by Dr. Dallinger, a new edition of which is promised for next July.

Chalk with Shells.—In a previous number I offered to send a correspondent a supply of Foraminiferous Limestone. Several readers have asked that I would also give them some. I shall have much pleasure in complying with their requests if they will kindly accompany their application with stamps to cover cost of postage on the material.

RED RAIN.—In connection with the recent falls of so-called red rain, I have received letters from two correspondents, one of whom enclosed a small quantity of material distributed by Captain C. J. Gray, which had been collected by him after a heavy fall of rain on December 28th, 1896, in Melbourne, Australia. I have had the material mounted, but the quantity which I received did not contain the variety of matter that some other correspondents have noted. Observed by transmitted light, there were few characteristic particles, but with the aid of a polariscope I was able to detect some small crystalline fragments of the nature of quartz, etc. It seems more than probable that the phenomenon arose in consequence of one of those heavy winds which have been known to carry dust from the Sahara as great a distance as 500 miles, and which in this case may have passed over some sandy tract in a like manner. The material has all the appearance of such dust. There are some interesting references to falls of red rain in P. H. Gosse's "Romance of Natural History," but none of them are of the same nature as the dust at present under consideration.

D. H. M. Whelpley.—I have to give you my best thanks for so kindly sending the numerous interesting papers in connection with chemical and pharmaceutical subjects, and especially for the engraving of the Pre-columbian Indian Flint Implement. This is certainly a most interesting and perfect specimen.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

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

LARGE COMETS. Prof. A. Kreutz, editor of the *Astronomische Nachrichten*, has recently issued a work giving the results of his computations and comparisons of the orbits of the comets of 1680, 1843 I., 1880 I., 1882 II., 1887 I., etc. These several objects offered some suggestive resemblances both as regards their physical features and their orbital elements. But they appear to have been, individually, distinct bodies revolving in ellipses of long period. They exhibited, however, a sufficient all-round similarity to warrant the inference that they originated from the same source, and may have primarily formed an immense comet, which encountered disturbances of such force as to disconnect its materials and distribute them into a family of large comets of various periods, and with perihelia remarkably close to the sun. The time of revolution of the comet of 1680 was about 8449 years, of 1843 I. 511 years, of 1880 I. and 1882 II. 800 years; but in the case of 1887 I. the elements are extremely uncertain, the comet being only observed on a few nights in the Southern Hemisphere. Certain other bright comets, in addition to those specified, exhibited features of orbit and aspect which indicate their possible identity with the class alluded to, but the observations were not very accurate, and reliable conclusions cannot be deduced from them.

NEW COMET. On April 23rd, a telegraphic dispatch from Sydney reported that a brilliant comet was seen in Australia, and the same object was observed at Capetown during the two hours preceding sunrise. It had a triple tail ten degrees in length. The astronomers at Yerkes Observatory are said to have picked up the comet on the morning of April 27th, and it was seen by several observers at Eastbourne, according to the newspapers, on May 1st, at 3 a.m., but as the comet did not rise in England until after 6 a.m. on that morning the observers must have been deluded by some false appearance. The perihelion passage occurred on April 24th, at a distance of about 23 millions of miles from the sun. The following extracts from an ephemeris by Kreutz, *Ast. Nach.*, 3712, will show that during May the comet rapidly receded from the earth, and became so faint as to be practically invisible in the strong twilight of the season:—

Date.		R.A. H. M. S.	Dec. °		Brightness.		Distance from Earth in Millions of Miles.
May 4	..	3 57 49	− 0	11·4	0·37	..	82
,, 11		5 31 19	+ 3	25·9	0·09	...	107
,, 21	..	6 20 18	+ 6	21·2	.. 0·03	...	138

On June 1st, the comet will be about one-hundredth part as bright as it was when near perihelion, and will be situated in about 100° + 8°, so that this object which afforded such a conspicuous aspect in the southern hemisphere, has virtually come and gone (like the fine comets of 1880, February, and 1887, January) under conditions which prevented a single glimpse being obtained by northern observers.

THE APRIL METEORS.—The weather generally was very favourable for the observation of these objects, and moonlight offered no interference until the later stages of the display. Usually meteors are very scarce in April, and this year proved no exception to the rule. At Bristol the writer obtained observations on April 13th, 17th, 18th, 19th, 20th, 21st, 23rd and 24th, and during watches amounting in the aggregate to 19 hours saw 122 meteors. The first Lyrid was recorded on April 18th, at 13h. 19m., and it was fortunately also mapped by Prof. A. S. Herschel at Slough. It descended at a normal elevation above the earth's surface, and its radiant at 266° + 33° proves that this centre, like that of the Perseids, moves eastwards during the time of its visibility. On April 20th, during a watch of five hours the writer noticed 29 meteors, but there was not a single Lyrid amongst them! Yet, on April 21st, during a watch of 3¼ hours 25 Lyrids were seen, and 27 other meteors. It was evident that on this night the shower reached a definite maximum. Allowing for time spent in registering the paths, etc., the horary number of Lyrids for one observer was about eleven. The radiant point on April 21st was at 270° + 33°, showing an easterly drift of 4 degrees of R.A. (equal 3 degrees of space) during the three nights. The following ephemeris will probably represent the place of the radiant pretty accurately on eleven nights, and it will be important to test it by future observations, but the shower is exceedingly feeble at its earlier and later stages, so it will be advisable to incorporate the paths of different observers:

Date.		α °	δ °	Date.		α °	δ °
April 15	...	263½	+ 33	April 21	...	271	+ 33
,, 16	...	264¾	+ 33	,, 22	...	272¼	+ 33
,, 17	...	266	+ 33	,, 23	.	273½	+ 33
,, 18	...	267¼	+ 33	,, 24	...	274¾	+ 33
,, 19	..	268½	+ 33	,, 25	...	276	+ 33
,, 20	...	269¾	+ 33				

1900 not being a leap year the effect will be that for some time in the future the maximum will occur one day later than formerly. Thus the Quadrantids will occur on January 3rd instead of January 2nd, the Lyrids on April 21st instead of April 20th, and the Perseids on August 11th instead of August 10th. The recent display of Lyrids was successfully observed by several observers in various parts of England. Prof. Herschel at Slough made a considerable number of accurate observations, and remarked the singular scarcity of meteors except on the special night, April 21st. He then saw 18 Lyrids in about three hours, nearly all 1st or 2nd magnitudes. Mr. C. L. Brook, of Meltham, near Huddersfield, counted between 40 or 50 meteors on April 21, including a number of Lyrids. One of the most brilliant of these appeared at 10h. 8m., and was also recorded by Mr. T. H. Astbury, at Wallingford, and the writer at Bristol. It fell from a height of 79 to 51 miles over the Midlands. But the most interesting meteor observed at more than one station during the recent display was that of a bright Cassiopeid which came into view at 11h. 22m. on April 21. Its radiant, from observations at Meltham and Bristol, was at 21° + 59° near δ Cassiopeiæ, and it descended from 66 to 44 miles in a path of 55 miles, directed from north to south over the counties of Carnarvon, Merioneth, and Cardigan, in Wales. Its velocity was 14 miles per second. It is remarkable that slow-moving fireballs often take their flights from this radiant near δ Cassiopeiæ in the spring months of April and May, though ordinary shooting stars come rarely from that focus in the vernal season. The fireball of 1891, April 2, had a radiant of 29° + 55°; that of 1876, April 9, at 17° + 57°; that of 1874, April 10, at 19° + 57°; that of 1893, April 15, at 15° + 59°; and that of 1877, May 30, at 20° + 58°. The various catalogues of meteoric observers contain other instances of brilliant slow-moving April meteors from the same radiant in Cassiopeia.

THE FACE OF THE SKY FOR JUNE.

By A. FOWLER, F.R.A.S.

THE SUN. On the 1st the sun rises at 3.52, and sets at 8.4; on the 30th he rises at 3.49, and sets at 8.18. He enters Cancer, and Summer commences on the 22nd at 3 A.M. Few sunspots are to be expected.

THE MOON. The moon will be full on the 2nd at 9.53 A.M., will enter last quarter on the 9th at 10.0 P.M., will be new on the 16th at 1.33 P.M., and will enter first quarter on the 23rd at 8 59 P.M. The following are among the occultations visible at Greenwich 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.
June 1	α Sagittarii	4·1	2 4 A.M.	111	164	3 13	220	212	16 20
„ 4	D.M. −19°5273	6·0	11.52 P.M.	31	52	12.41	312	326	17 18
„ 5	B.A.C. 6537	5·5	2 49 A.M.	102	94	3 50	227	210	17 21
„ 8	ι Capricorni	5·2	2 55 A.M.	109	126	[illegible]	261	268	20 21
„ 25	B.A.C. 4531	5·7	7 57 P.M.	101	94	9 18	302	283	9 7
„ 28	ω^1 Scorpii	4·3	11.15 P.M.	53	67	12 16	315	291	12 10
„ 28	ω^2 Scorpii	4·6	11 50 P.M.	104	82	12 48	267	240	

Attention may be specially drawn to the occultation of ω^1 and ω^2 Scorpii on the night of the 28th.

The Planets.—Mercury is an evening star throughout the month, reaching greatest easterly elongation of 24° 39′ on the 16th, and, apart from the strong twilight, is very favourably situated for observation. On the 10th, he sets 1h. 55m. after the sun; on the 16th, 1h. 45m.; and on the 18th, 1h. 40m. after the sun. On the 16th the planet will be to the south-west of Castor and Pollux, roughly at the same distance from Pollux that this star is from Castor.

Venus is an evening star, having passed superior conjunction on May 1st. At the middle of the month she sets a little less than an hour after the sun, and at the end of the month almost exactly an hour after the sun.

Mars may still be watched in the early evening. On the 1st he sets a little before 1 A.M., and on the 30th about 11.20 P.M., his apparent diameter diminishing from 7″·2 to 6″·2. On the 15th the illuminated part of the disc will be 0·890, the planet having passed quadrature on May 28th. The path is direct, or easterly, through the south-eastern part of Leo.

Jupiter may be observed before midnight throughout the month, rising on the 1st a little before half-past ten, and on the 30th a little after eight. The planet will be in opposition on the 30th, but as his declination is then 23° south, his altitude on the meridian in London will be less than 16°. The path is retrograde, or westerly, through Sagittarius. On the 15th the apparent polar diameter of the planet will be 43″. The more interesting satellite phenomena at convenient hours are as follows:—

				H.	M.	S.						H.	M.	S.
22nd.—	I.	Ec.	D.	11	4	14	28th—	IV.	Sh.	I.		9	23	0
23rd—	I.	Sh.	E.	10	27	0		IV.	Tr.	I.		9	47	0
	I.	Tr.	E.	10	38	0		IV.	Sh.	E.		11	30	0
25th—	II.	Ec.	D.	11	53	41		IV.	Sh.	E.		11	51	0
26th—	III.	Sh.	E.	10	26	0	30th	I.	Tr.	I.		10	1	0
	III.	Tr.	E.	10	49	0		I.	Sh.	I.		10	4	0
27th—	II.	Sh.	E.	9	47	0		I.	Tr.	E.		12	21	0
	II.	Tr.	E.	9	56	0		I.	Sh.	E.		12	21	0

Attention has been drawn by Mr. Crommelin to the specially interesting phenomena on the 30th, on which date there will be a transit of the earth across the sun's disc as seen from Jupiter. Satellite I. will almost occult its own shadow on the planet, but as the shadow will be slightly the larger, a dusky ring may be expected to surround the satellite.

Saturn is in Sagittarius, a little to the east of Jupiter. On the 15th, the apparent diameter of the planet will be 16″·8, and the major and the minor axes of the outer ring respectively 42″·4 and 17″·6. The ring is widely open, with the northern side towards us.

Uranus is now fairly well placed for observation, being in opposition on the 6th, but like Jupiter and Saturn, rather low in the sky. The path of the planet is a short westerly one in the most southerly part of Ophiuchus; it will be found to the west of the stars ξ and ο, roughly equidistant from them, and at a distance a little greater than that between the two stars.

Neptune is in conjunction with the sun on the 21st, and cannot be observed.

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 nearly 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.
(Mrs. Baird.)

No. 1.

1. B to QB2, and mates next move.

No. 2.

Key-move.—1. B to Kt2.

If 1. . . . P to B4, 2. Kt to Kt5.
1. . . . P to B5, 2. R to K4ch.
1. . . . P×P, 2. Kt to Q8.
1. . . . P to Kt4, 2. P×P en passant.

The following are at present the leading scores in the Solution Tourney:—

Twenty-seven points.—S. G. Luckcock, J. T. Blakemore, G. W., C. Johnston, A. C. Challenger, W. Jay.

Twenty-six points.—J. Baddeley, H. Le Jeune, G. Groom, F. J. Lea, W. de P. Crousaz, W. H. S. M., F. Dennis, C. C. Massey, Eugene Henry, A. J. Head, J. Sowden, G. W. Middleton, E. Hunt, Vivien H. Macmeikan, J. E. Broadbent, C. Child.

Twenty-five points.—Endirby.

Twenty-four points.—C. F. P., G. A. Forde (Capt.), A. H. Machell Cox, Alpha, H. Boyes.

Twenty-three points.—A. E. Whitehouse, J. M. K., W. Nash, C. C. Pemington.

Twenty-two points.—F. A. Wilcock, who did not attempt the January problems, but has since scored the maximum number of points.

All the above score 5 this month, with the exception of Endirby, 4 (1 point deducted for incorrect claim for a second solution), and A. E. Whitehouse, 2.

Correct Solutions of both problems have also been received from W. Boyd and A. Kempster.

Endirby.—After 1. Q×Bch, K to Q3 there is no mate.

W. H. S. M.—The law concerning post-marks was stated very clearly before the competition began. There can be no doubt as to its interpretation in the case you mention.

F. O. Wilhelmy.—April solution correct; too late to acknowledge last month.

W. H. Gundry.—Many thanks. It is marked to appear later in the summer.

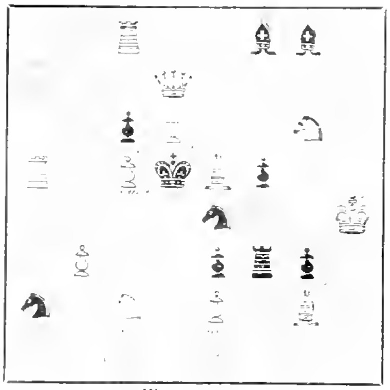
W. *Boyd.*—Your problem beginning with a check is not sufficiently deceptive. In addition there is a quadruple mate after 1. K to Q4.

PROBLEMS

No. 1

By Mrs. W. J. Baird.

BLACK (9).



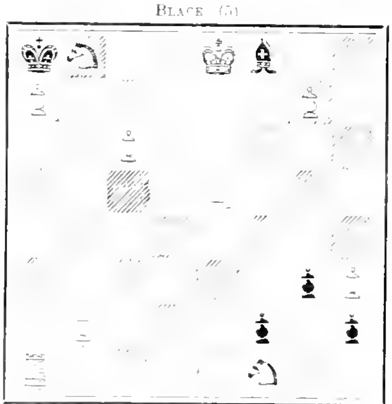
WHITE (12).

White mates in two moves.

No. 2

By D. L. Anderson.

BLACK (5).



WHITE.

White mates in three moves.

CHESS INTELLIGENCE.

The North *v.* South Correspondence Match came to a conclusion on April 15th. Five games remain to be adjudicated, but their result cannot affect the match, which has been won by the South. The score of the 95 finished games is as follows:

NORTH			SOUTH		
A. Burn, Liverpool	[illegible]		W. H. [illegible]	[illegible]	
G. A. S[illegible], B[illegible]			[illegible]	1	1
F. D[illegible], Newcastle			W. W[illegible], L[illegible]	1	1
I. E. [illegible], Liverpool			D. Y. M[illegible]	1	
F. P. W[illegible], Leeds			H. W. [illegible]	1	
[illegible], Manchester			[illegible]		
Rev. W. [illegible]			F. J. H. [illegible]	1	1
J. W. [illegible]			S. [illegible]		1
W. Atkins, H[illegible]			H. [illegible], L[illegible]		
J. B[illegible], West H[illegible]			H. [illegible], H[illegible]		
C. H. W[illegible], M[illegible]			[illegible]		1
W. B[illegible]			F. H. [illegible]	0	0
J. A. W[illegible]			[illegible]		
E. G. S[illegible], N[illegible]			W. [illegible]	1	
H. F. Wr[illegible]			[illegible]	0	0
[illegible], M[illegible]			H. E. M[illegible]	1	1
Dr. Shaw, [illegible]			F. [illegible], L[illegible]	1	1
J. Rogers, L[illegible]			C. J. W[illegible]	1	1
I. H. Wright, W[illegible]			E. [illegible], L[illegible]		
F. R. Clifford, Huddersfield			A. [illegible]	1	
Dr. Lowenthal, Liverpool	1	0	A. A. Bowley, Brighton	½	1
J. Musgrove, Leeds	½	1	F. N. Braund, Brighton	½	0
T. H. Lambert, Manchester	0	0	R. C. Turnbull, London	1	1
W. J. Greenwell, Newcastle	0	½	F. H. Miles, Hastings	1	½
G. H. Harrison, Sheffield	1	0	S. Van Gelder, Bath	0	1
H. Doyle, Egremont	1	½	F. Anspach, London	0	½
J. Foulds, Bradford	0	0	M. Michael, London	1	1
S. Kerr, Lancaster	1	0	Dr. Deighton, Cambridge	0	1
J. S. Brookbank, Cumberland	0	½	W. E. Vyse, London	1	½
J. Nicholson, Newcastle	1	1	F. W. Flear, Huntingdon	0	0
R. H. Philip, Hull	½	0	H. Erskine, Brighton	½	1
J. Higgins, Cumberland	0	1	W. Bridger, Sussex	1	0
F. R. England, Liverpool	0	1	Dr. Dunstan, London	1	0
W. Gledhill, Dore, Bks.		1	T. B. Girdlestone, London	½	0
H. Greenwell, Newcastle	1		H. G. Lee, Bath	0	½
F. C. Howell, Leeds	1	½	H. L. Bowles, London	0	–
S. M. Cockin, Wakefield	0		T. M. Friedmerger, Hastings	1	½
A. E. Greig, Birkenhead	0	0	T. W. Newman, London	1	1
J. J. Shields, Hull	1	1	T. E. Hoyden, London	0	0
W. D. Haydon, Newcastle	0	0	J. A. Watt, Hastings	1	1
M. Jackson, Hull	1	1	H. D. O'Bernard, Hanton	0	0
F. Stansby, Middlesboro	1	1	F. Purchas, Brighton	0	0
W. Nixon, Newcastle		1	G. W. Williams, Essex	0	0
C. W. Roberts, Bedford	1	0	Col. Chisholm, Cheltenham	0	1
C. J. B. Lowe, Manchester	0	½	T. Taylor, Plymouth	1	
D. Cook, Spennymoor	1		G. B. Capel, Bath	0	½
M. Holt, Manchester	0	0	G. V. Sutton, London	1	1
C. Croft, Burley-in-Wharfdale	1	1	J. A. Green, London	0	0
W. H. Burgess, Manchester	0		Col. Law, Gloucestershire	1	½
C. Pratt, Carlisle	0		W. Mears, Torquay	1	½
Total	41		Total	53½	

The final score is—South, 47; North, 43.

The Sixth Anglo-American Cable Match took place on April 19th and 20th. Fortunately Mr. Blackburne found himself able to play after all, and the British team was greatly strengthened by the inclusion of Mr. Mason. As the Americans had won in the two previous years, it was of the utmost importance that their opponents should at least draw the present match and thereby prevent the Newnes Challenge trophy from leaving these shores for ever. This, after a hard struggle, they succeeded in doing, the score being as under:—

GREAT BRITAIN.		U.S. AMERICA.	
J. H. Blackburne	0	H. N. Pillsbury	1
J. Mason	1	J. W. Showalter	0
F. J. Lee	½	J. H. Barry	½
D. Y. Mills	½	A. B. Hodges	½
H. E. Atkins	0	E. Hymes	1
G. E. H. Bellingham	½	H. Voigt	½
W. Ward	1	F. J. Marshall	0
E. M. Jackson	½	S. W. Bampton	½
Herbert Jacobs	0	C. J. Newman	1
R. P. Michell	1	C. Howell	0
Total	5	Total	5

Later in the month a cable match between the American Universities and a team representing Oxford and Cambridge Universities likewise ended in a draw, the score being three games all.

Mr. Lawrence won the City of London Championship (for the fifth time) without losing a single game, winning 18 and drawing 3. The order of the other prize-winners is not yet determined, but Mr. Herbert Jacobs will probably be second; Mr. Ward, 16½, third; Mr. E. O. Jones or Dr. Smith, fourth; and Mr. A. Curnock, sixth.

Miss Finn has won the championship of the Ladies' Chess Club, Mrs. Fagan being half a point behind, and Mrs. Anderson third.

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

The yearly bound volumes of KNOWLEDGE, cloth gilt, 8s. 6d., post free.

Binding Cases, 1s. 6d. each; post free, 1s. 9d.

Subscribers' numbers bound (including case and Index), 2s. 6d. each volume.

Index of Articles and Illustrations for 1891, 1892, 1894, 1895, 1896, 1897, 1898, 1899, and 1900 can be supplied for 3d. each.

All remittances should be made payable to the Publisher of "KNOWLEDGE."

"Knowledge" Annual Subscription, throughout the world, 7s. 6d., post free.

Communications for the Editors and Books for Review should be addressed Editors, "KNOWLEDGE," 326, High Holborn, London, W.C.

KNOWLEDGE

AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

VOL. XXIV.] LONDON: JULY, 1901. [No. 189

CONTENTS.

THE SIZE OF OCEAN WAVES. IV.

(Concluding article.)

By VAUGHAN CORNISH, D.SC.(VICT.), F.G.S., F.C.S., F.R.G.S., *Associate of the Owens College.*

THE diagram Fig. 1 is composed of two parts. In the upper we have a simple wave of length 300 feet and height 15 feet, and a simple wave of length 550 feet and height 15 feet, which are combined in the third line, giving a slightly irregular wave surface of which the average amplitude for the portion shown is about 16 feet, and the average distance from ridge to ridge is 300 feet.

Shorter waves, however, flatten out more quickly than longer ones, so that after the wind has subsided the shorter will cease to be the more conspicuous wave and the sea will present the appearance shown in the fifth line, an irregular swell with an apparent wave length averaging about 500 feet for the portion shown. For the purpose of this illustration I assume that the longer swell has not yet travelled completely beyond the shorter, as, of course, it will when sufficient time has elapsed.

Fig. 2 is a further consideration of the conditions which determine the apparent length of one wave which, I think, greatly influence the record of average observed length and height.

In this diagram, which is drawn rather roughly, but not too roughly for the purpose in hand, the shorter wave, 150 feet long and 7½ feet high, is plainly visible on the third line throughout most of the distance, but is as plainly subordinate to a longer wave. The wave shown in line 2 is 100 feet long and 20 feet high, it is not only longer than the wave in line 1 but is equally steep, and, therefore, so far dominates the shorter wave that an observer on board ship, who must concentrate his attention if he is to get results at all, measures only the crests A, B, C, D, the average interval between which is 100 feet. The lower three lines of the figure show the combination of two same waves when of equal amplitude. The apparent wave length is now 150 feet.

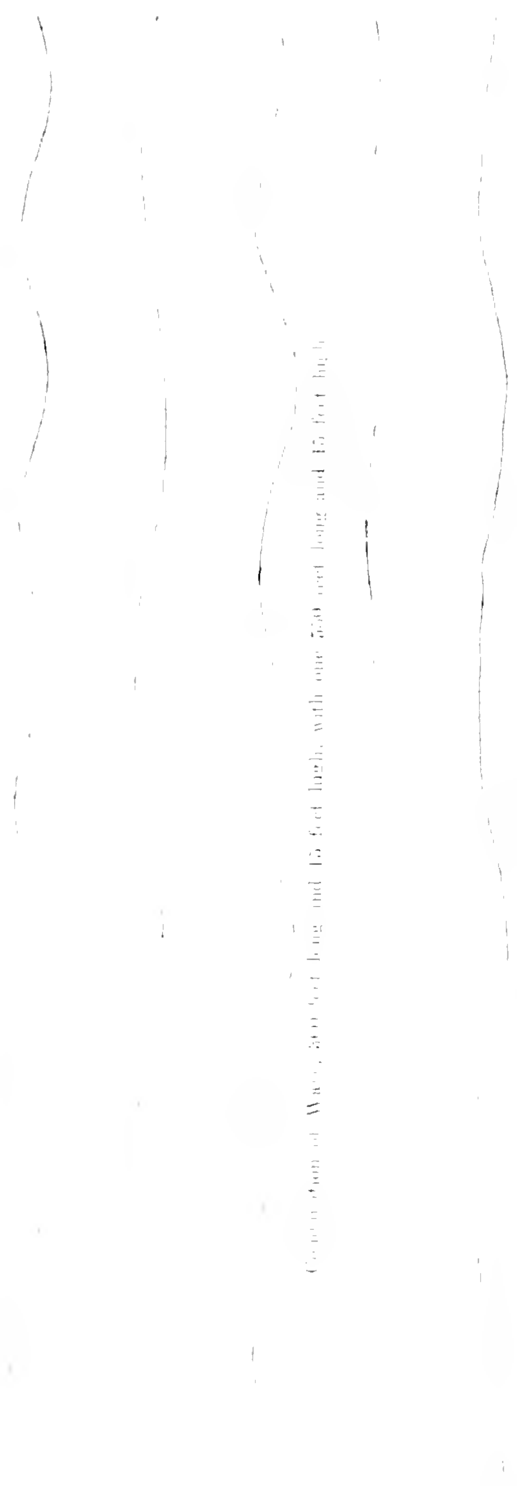
For the advancement by observation of our knowledge of ocean waves it is desirable that measurements of individual heights and lengths should in future be recorded, and the analysis into constituent waves attempted. The want of a fixed datum line will probably render such analysis imperfect, and the absence of fixed relation between the height and length of the components is a difficulty; nevertheless an approximate analysis could be made, and this would be a decided advance on the present condition of affairs.

We have here to deal with the measurements at present available; these record the average size of the most conspicuous ridges seen from on board ship (reckoning amplitude as the vertical height from the trough to the next succeeding crest without reference to any datum line), and the average does not seem to differ much from the size of the longest of the steep waves running at the time, which I propose to call the dominant wave. It has been the custom of observers as far as possible only to take measurements when the waves were fairly regular, and to avoid the very common condition indicated in Fig. 3, where the sea is agitated by short groups of high waves with long "smooths" intervening.

Let us now proceed to enquire what light the published observations throw upon the relation of the observed size of the waves to the strength of the wind, the distance through which it acts, and the size of the sheet of water. Tables given in the previous articles show the size of the waves in relation to the strength of the wind, the size of the waves being taken when the sea has attained its maximum roughness. In Paris' table the lengths of the waves are given. From those of Desbois and Wilson-Barker we can calculate the wave length roughly by multiplying the height by about 18. For small waves the number may be 15, for large waves 20. From the length of the waves the velocity is simply calculated by the *formula*:—

Speed of Wave = 2¼ × square root of length.
(in feet per second) (in feet)

This formula, derived from the theory of regular trochoidal waves, has been found to apply to the observed waves at sea with sufficient accuracy for our present purpose. We find that the speed of waves (*i.e.*, the dominant form) in a storm at sea is much less than that of the wind. The long oceanic swells met with after a storm have, however, a velocity approaching that of wind in a strong gale; so much may be said without going into details as to the discrepancy between different records of wind velocity, assuming merely that the conventional numbers expressing wind force are roughly comparable in the hands of experienced observers, and that the last set of the table velocities (that given by Captain Wilson-Barker) may be advantageously substituted for the earlier ones.



Combination of Waves, 500 feet long and 15 feet high, with one 550 feet long and 15 feet high.

FIG. 4.—Combination of these Waves when the shorter has subsided to the proportions shown in the fourth line.
Scale—Horizontal, 1 in. = 200 ft.; Vertical, 1 in. = 100 ft.

Taking 28 feet as the average height of the waves in a violent storm in the ocean, and assuming that the average length is then 20 times the average height (which is known to be approximately the case), the wave length would be 560 feet, and the speed of the wave, therefore, 53 feet per second, 36 statute miles per hour. The wind would then be blowing some 60 miles per hour relatively to an observer stationary upon the water, but only 24 miles an hour relatively to the waves. Waves of greater speed in the same storm would be subjected to a lighter wind, and a wave travelling 60 miles an hour would be in still air. It is not difficult to see, therefore, that the most conspicuous waves in the storm, even *en pleine mer*, will not be the very longest which the wind may be supposed capable of directly creating. The growth in height of the longer waves is thus limited by the diminution of the power of the wind to press upon the more swiftly retreating form. The growth in height of shorter waves, on the contrary, is limited by the circumstance that the slowly moving ridge of water, being subject to almost the full force of the gale, gives way if it become high and steep, bursting in a shower of spindrift.

If we look at the waves raised by the wind upon a pond we see that, commencing with wavelets about an inch long close to the windward shore, there is an increase in height and wave length as we recede therefrom. The waves at any point on the pond soon attain the maximum dimensions compatible with their distance from the windward shore, and however long the wind may blow no further increase in their size takes place. The same phenomenon can be well seen on a lake or any such body of water not subjected to the disturbing effect of a swell.

The following Table (IX.) shows the relation between

TABLE IX.

Locality.	Estimated Fetch in Miles (geographical).	Observed Height.	1.5 √ Length of Fetch.	[illegible]
Scalpsie Bay	1·0	1·0	1·5	3·0
Firth of Fort	1·3	1·0	1·8	3·2
Granton	2·8	1·5	2·5	3·75
Craig Nure ...	3·5	2·0	2·9	3·9
Granton	6·0	1·0	3·7	4·6
Lough Foyle	7·5	4·0	4·1	4·36
Clyne	9·0	4·0	4·5	5·25
Colonsay	9·0	5·0	4·5	5·25
Dysart ...	10·0	4·2	4·9	5·5
Invergordon	11·0	3·5	5·0	5·7
Lough Foyle	11·0	5·0	5·0	5·7
Glen Luce Bay ...	13·5	5·5	5·6	6·1
Anstruther ...	24·0	6·5	7·5	7·7
Lake Geneva (by Minard)	30·0	8·2	8·2	8·37
(by Buckie)	31·0	7·0	8·4	8·5
	38·0	7·5	9·2	9·2
...	38·0	8·0	9·2	9·2
	40·0	8·0	9·55	9·5
Macduff ...	44·5	8·0	10·02	9·9
... ...	45·0	10·0	10·20	10·0
Douglas (St. George's Channel)	65·10	10·12	12·0	
Kingstown ...	114·0	15·0	16·0	15·25
Sunderland (distance measured from Broken Bank)	165·0	15·0	19·3	18·15

the height of waves and the length of fetch of the wind according to T. Stevenson. It is taken from the

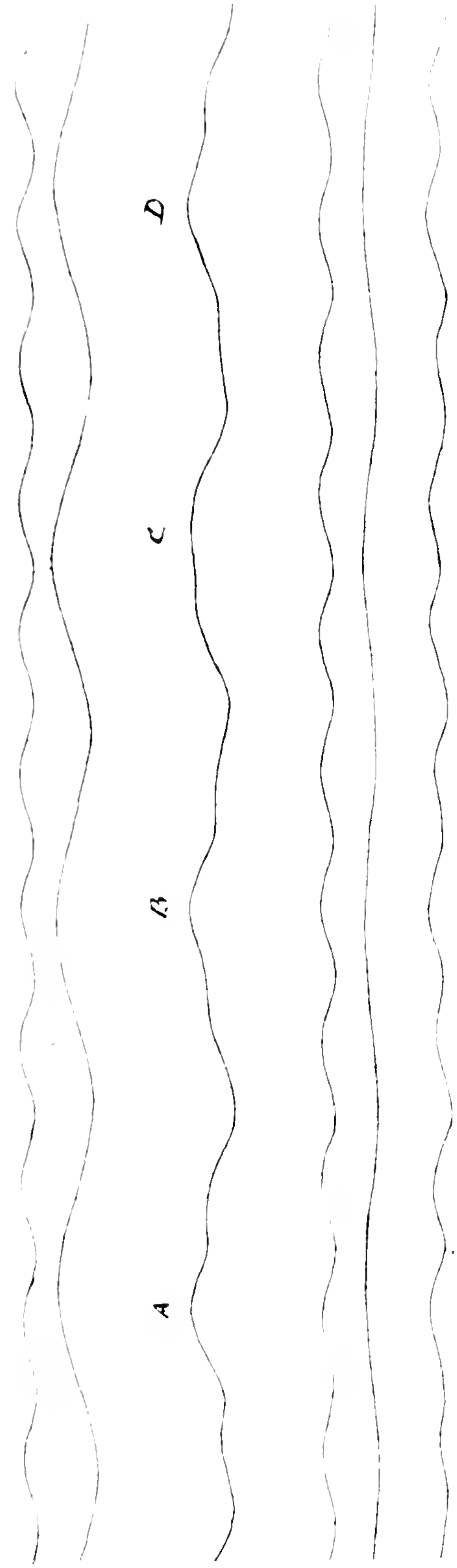


FIG. 2.—The third line shows the Combination of a Wave, 150 feet long and 7½ feet high, with one 400 feet long and 20 feet high; the sixth line shows the combination of the first wave with one 100 feet long and 7½ feet high: the first combination is of waves equally steep, the second of waves equally high.

Scale.—Horizontal, 1 in. = 200 ft., Vertical, 1 in. = 100 ft.

article *Harbours*, in the Encyclopædia Britannica, IXth edition. Column 2 gives the distance to the nearest shore in the direction from which the waves come, column 3 the observed heights, and columns 4 and 5 the heights calculated from the empirical formulæ which best satisfy the results of observation.

It required many years to compile this table, as it gives the observations of "the effects of heavy gales which could only be made at long intervals of time." The author goes on to say that "the formula h = 1·5√d [illegible] indicates pretty nearly the heights of waves during heavy gales, at least in seas which do not differ greatly in depth from those where the observations were made. The formula is of course inapplicable where the water is not of sufficient depth to allow the waves to be fully formed, or where it becomes so shallow as to reduce their height after they are formed. It must be observed that in short fetches, as in narrow lochs or arms of the sea, waves are raised higher during very violent gales than the formula indicates, though it does not appear that such waves go on progressing in height in the same ratio for any considerable distance."

The observed heights agree well with those calculated from the simpler formula (which makes height vary with the square root of the distance) between the limits of a six and a sixty-five mile stretch of water, between which limits, moreover, there is a fairly numerous and uniformly distributed set of observations. Above that distance there are two values given in the table, viz., for distances of 114 and 165 miles. The former agrees well with the formulæ, the latter does not. Stevenson obtains the "length of fetch" by measuring on the chart the distance to the nearest shore in the direction from which the wind is blowing on the lee shore. When we have to do with greater distances, however, the stretch of water throughout which the wind acts simultaneously in one and the same straight line cannot be thus assumed. If in such cases we restrict the term length of fetch to the space over which the wind is acting throughout in one direction, then, since we have no sure means of ascertaining what that distance is, the notion of "length of fetch" of wind is of little further use to us; if, on the other hand, we continue to note the size of waves in connection with the distance from land in the direction from which the waves are coming, we must not expect to find a continuance of such comparatively simple relations between this distance and the size of wave. Nevertheless it is desirable to take note of this, which I may call the *length of run*, for since ocean waves do not quickly subside, when the wind ceases, the train of waves may be subjected more than once to wind blowing over them in the direction of their movement. Stevenson's values for heights of waves for distances up to 100 miles may be provisionally accepted as applying to those far from the lee shore. At 141 miles the height calculated from his (simpler) formula is 18 feet, and this accords fairly with the experience of waves in the English Channel during easterly gales. But in the western Mediterranean (off the Riviera) the average height of waves in a storm does not appear to exceed 18 to 20 feet, though the length of run may be taken as 500 miles. Stevenson's formula if stretched to apply to this case gives a height of nearly 37 feet, and is, therefore, no longer applicable to measurement from the windward shore. Whether or not a storm wind blowing in a straight line over 500 miles of water would raise waves averaging 37 feet in height, it is nearly certain that such waves would not be normal in the Mediterranean or any other enclosed or nearly enclosed sea. Thus the greatest waves observed by Paris

* See Adm. W. H. Smyth, "The Mediterranean" [illegible]

in the southern part of the China seas, during a strong N.E. gale of several days' duration, were 21 feet in

Fig. 3.—Combination of Waves of 200 feet and 350 feet length respectively.
Scale: Horizontal, 1 in. = 200 ft.; Vertical, 1 in. = 100 ft.

height. This was off Cape Varella, with a length run of about 500 miles. Probably the scale of the cyclonic disturbances is larger in the great oceanic areas where meteorological conditions are uniform over large areas. This would give a greater real length of fetch to wind of a given direction and a longer period of operation. The waves of violent storms in the oceans may be reckoned to be one-half as high again as those of the seas. I take provisionally 20 feet average and 30 feet occasional single waves for the seas, and 30 feet average with 45 feet occasional single waves for violent storms in the oceans, values which in high southern latitudes are probably somewhat exceeded. This difference I ascribe *partly* to the large scale of the weather in the oceans, with increased length of fetch and increased duration of wind.

Let us consider separately the contributing cause, greater length of run of the waves. It is the shortness of the principal waves first formed by wind which limits their height. The increase in length of the dominant form is a gradual process involving the destructive interference of the shorter waves, and the longer waves must attain a greater amplitude than the shorter before they become conspicuous in the presence of the latter, as I have already explained. Not only does it take a considerable time and length of fetch to make the longer waves the dominant form in a gale, but since they travel more swiftly than the short ones they sooner reach the lee shore. Thus in enclosed seas they soon reach the margin and are put out of action.

In lakes very long waves, such as move with nearly the velocity of the wind in a strong gale, would be too flat to be visible, even after the wind has ceased, except perhaps under a very low angle of illumination, and this flatness would prevent their breaking on the shore, though they might perhaps produce a welling up and down in a period of about 15-18 seconds for the complete double oscillation.

On the other hand, longer waves preserve their form for a much greater time than short ones, as they travel on after the cessation of wind, the rate of flattening being theoretically inversely proportional to the square of the wave length. Thus in the oceans, when a storm has occurred far from a lee shore, the shorter waves die out by subsidence before the longer waves run out, and the sea between the place where the waves were raised and the lee shore is left heaving for days with a long swell. This effect is best seen where the ocean encircles the globe in high southern latitudes. Here the storms come from the westward, the strongest winds are westerly, there is always a swell running from the westward, and there is no eastern shore, the length of run of the waves being practically infinite on the re-entrant surface of the circumpolar water. As each westerly gale rises it blows over the ridges of the heavy swell already running, pressing strongly on the subsiding back, and opposing less the rising front, increasing thus the height of each billow. Thus in the swelling ocean the storm waves of 400 to 600 feet do not have to wait so long before attaining their maximum steepness and becoming the dominant form as if they had to be slowly developed by the tedious process of destructive evolution from the short waves first formed when smooth water is ruffled by the wind.

Marked as is the difference between the storm waves of the Mediterranean, or other seas, and those of the oceans, it is the swell which comes in upon the shore facing the open ocean which we instinctively recognise as the true index of a vaster expanse of water. These swells, as I have pointed out, must have, in deep water, a speed but little inferior to that of the wind during gales.

The development of considerable amplitude in such swells must require a good deal of time, and it is not unreasonable to think of those which come in upon our western shores as having gradually grown (in spite of intervals of partial subsidence) during a run of 3000 miles from the shores of America, experiencing at intervals the force of westerly gales.

THE RELATIVE SPEEDS OF SOME COMMON BIRDS.

By Charles A. Witchell.

The flight of a bird is usually so devious that its speed is not easy to determine, and when the journey is directly from one point to another the uncertainty in the mind of an onlooker as to where the flight will end is a further hindrance to accurate observation. A bird in the open, again, flying across the plane of vision and far from a fixed point, requires the preconception of its distance from us before yielding any data of its speed. The difficulty of the subject, indeed, must be urged as the most reasonable excuse for the diversity of rate at which birds have been stated to fly, even by careful observers. The subject of flight is a large one, on which the reader cannot do better than consult the article in Professor Newton's *Dictionary of Birds*. I do not propose to enter into it further than to mention some incidents I have seen in which the relative speeds of some common birds have been tested by the birds themselves, or they have provided man with a means to readily gauge their celerity for a few moments.

The commonest test of such speed is the pigeon-race, but in this the direction of the wind in relation to the birds may be considered the dominant influence. The questions of distance and familiarity with the course also arise. Independently of aid from the wind, 40 miles per hour would seem to be about the full speed for a good pigeon flying a long distance. I have had some experience in this matter, having "timed" for a good many races of the Southern Counties Club years ago. I am speaking, of course, of flight at a moderate elevation, such as pigeons generally affect. With the data available, none would dream of saying that a pigeon could fly at, say, 70 miles per hour against a moderate wind.

With regard to wild birds generally, not having such sure data for guidance the imagination has been allowed fuller play, with the natural consequences.

The swift affords a common illustration. The writer of an article in the *Daily News* thought that the swift could distance any falcon, and attain a speed of 150 miles per hour. I saw an adult male hobby falcon in the flesh, shot on a swift which it had overtaken in fair flight. A friend of Major Hawkins Fisher had seen a similar incident; and he himself bears witness to the wild alarm aroused in some hirundines by the appearance of a hobby from which they sped away, instead of mobbing it as they would have a slower hawk. Also, one of Major Fisher's peregrine falcons, even after the usual tethering of such captives, was able to chase a swift up and down the sky for a minute or more.

One day, travelling by express train through a valley, I noticed that the trees proved the wind to be blowing gently in the direction of our travel; and I also observed that the swifts passing along the valley, even "with" the wind, did not move so fast as the train, which was not exceeding the rate of some 45 miles per hour. The birds seemed to be flying at their usual pace when feeding.

Another bird whose speed seems to be overestimated is the sparrow-hawk. I have seen it compared to a cannon-ball in celerity; but the suggestion is absurd. A bird which arrives on the scene at full speed has a great advantage over others sedately feeding, so far as the chances of delivering an attack are concerned; and this may be partly the reason why so many of the smaller birds rise on the wing when alarmed by the sight of a hawk. It is as though they considered that, given a fair start, they might disregard the enemy. We, seeing a finch or a starling taken in a moment, often do not weigh the fact that the victim was hardly on the wing, and probably rising, when the bird of prey came like a whirlwind and overwhelmed it. The sparrow-hawk does not, more than any other, like a long "stern-chase," but prefers to attack with the advantage of a surprise when darting from a tree or around the corner of a wood, or when stooping with splendid speed from a poise several hundred yards above the ground. Even if it discovers its prey when traversing the country at a lower elevation, it has still the power of a fair momentum to take full advantage of the chance of a swooping rush at the prey, which is probably on the ground. Of course, when a rook is watched chasing a sparrow-hawk across the sky, there is nothing to show that the latter is seriously trying to fly at speed. On the contrary, it generally seems in such a case that the hawk is relying mainly on its soaring powers to avoid the attack. And it is remarkable indeed with how little apparent effort the hawk will soar up and up from the rook, which, all the while, is obviously exerting itself frantically. On the other hand, it is generally to be seen that when the birds are flying at a level, the rook has no difficulty in overtaking the hawk, who, after a turn or two, begins to go up, as already stated. The kestrel seems more often to evade its enemies by a turn of speed, though it also takes to the soar readily. Last autumn I saw a fine female kestrel harried by two peewits, which swooped at it alternately very prettily and with surprising persistence. At last the hawk, seemingly tired of "putting out" (as a falconer would say) these active birds, went straight ahead apparently as hard as it could; and then one could see that the peewits were not able to overtake it, though they followed to some distance. The same thing happened with the crow; the latter chased the hawk, but was at last outflown in a sheer straight flight.

Returning to the sparrow-hawk, it is by no means always successful in taking a small bird, even when the chase is over an open field. I have never seen it attempt to take a lark that had anything of a fair start. I never saw a kestrel attempt this prey; and I have seen a skylark go singing past a hovering kestrel (seemingly only a few yards distant) as unconcernedly as though the latter had been a pigeon.

One unsuccessful flight by a sparrow-hawk was very pretty to witness. A fieldfare was attacked far from covert of any kind. The quarry went off at its best, and the hawk raced after it, and overhauled it; but the fieldfare, with a ready turn (an upward turn it seemed) put out the hawk and gained several yards start, to return upon its former course, with the hawk speeding after, as before. Another turn saved the fieldfare, and back it went, for the third time, apparently covering just the same ground; and once more the upward spring saved it. It shot up still further this time, and the hawk gave up the chase. It should be said that the hawk was a male, and therefore not so very much larger than the fieldfare. Another male sparrow-hawk was not more fortunate with a greenfinch which he chased out of a wood, and hustled greatly, but could not catch; and with a loud twitter the little bird went gaily off.

However, in forming any estimate of the performances of animals, it is well to be able to effect a comparison with some common type; and to gauge the speed of common birds we cannot take a more familiar species than the house-sparrow. The homing pigeon we know can be relied on to attain, under fairly easy conditions, a speed of 60 miles per hour, or considerably more. The sparrow, surely, could never do anything like that! But the fact is that for a short distance the sparrow is well able to keep up with a good homer, and even when flying behind and below it (and therefore in a more disturbed region of the air) to gain enough additional momentum to deliver an attack. We know that the larger and heavier the bird (given a fair wing-spread), the greater its speed; but there is no getting away from this fact of the sparrow overtaking the pigeon. I often saw this at Stroud, the pigeons being excellent homers of pedigree and reputation, and the sparrow an old male that lived near them. I have since seen the same performance enacted elsewhere. In each case it was clear that the pigeon did not relish the attack, but did its utmost to get out of the way. I have several times seen a sparrow chase a starling in the same manner, the latter uttering its cackling alarm-cry. At Stroud it seemed to me that a starling pursued in this way often went at once to perch in a tree, where the smaller bird would not, so far as I know, continue the assault. A few days ago I saw a male chaffinch chase a starling from a Scotch fir, much affected by chaffinches in spring; and in this case, also, the smaller bird seemed to have no difficulty in overtaking the larger.

In February last I witnessed the occurrence of even greater audacity in a sparrow. In spring the sparrow regards the jackdaw with almost as much fear as it views a hawk, in fact, with much more than it sees the kestrel. This is no doubt due, not to adult sparrows being attacked but to their young being so often removed to supply the larder of the young jackdaws. The daw, ready enough to attack an adult small bird upon occasion, never hesitates to seize a young one if the chance offers. On the occasion in question I saw a sparrow carrying something large over a house. It dropped the burden in the hollow of the roof, and descended there. Along came a jackdaw, soaring about for food, as they do all day at Cheltenham, and down he went suddenly on the roof, returning at once with a nice piece of bread, which he ate on the chimney. He then took wing, and at once the sparrow came after him. Away went the daw, and close behind followed the sparrow, making frequent pecks at him. Stranger still, the jackdaw was clearly seeking to avoid the attack, but vainly. The birds made three good circles; and in the third the daw was swerving like a tin plate thrown from the hand, and close above the garden trees. The sparrow now gave it up, and descended into a roadside tree, while the jackdaw went away. I moved on and passed the sparrow, which was then chirping in that loud and continuous manner which seems to be the nearest approach to singing attained by the species. Possibly he was feeling proud of his victory.

At Charlton, last spring, a sparrow and a swift had decided upon the same site for a nest, for which they were fighting. The hole was under a thatched roof, and so often as the sparrow ensconced himself therein, the swift darted up and dragged him out again. Often the birds fell some distance together before separating. Once they nearly reached the ground. After one of these tussles, the sparrow chased the swift to some distance, and although he could not nearly overtake it, he flew "a very good second" even to that rapid leader, which was certainly frightened and doing its utmost to outpace him.

FOUR-HORNED SHEEP.

By R. LYDEKKER.

Of late years, at any rate, the attention of British breeders of sheep and cattle has been directed to the obliteration rather than to the development of horns; these weapons of offence and defence being not only quite unnecessary to domesticated animals which are never exposed to the attacks of beasts of prey, but often being the cause of serious damage, either from the animals fighting when in the open, or goring one another when crowded together during transit by rail. Among cattle the estimation in which "polled" breeds are held at the present day, and the practical disappearance of the old-fashioned long-horns, are excellent examples of this fashion; while among sheep, if we except the mountain and Dorset breeds, the majority of those bred in this country are hornless.

If, however, fashion and custom had set in the opposite direction, there is little doubt that some extraordinary developments in the form, size, or number of the horns might have been witnessed in both these groups of animals. Length of horn was indeed a feature in the old-fashioned breed of British long-horned cattle, and the massiveness and size of the horns of the humped cattle of Gallaland and Abyssinia, as well as the length frequently attained by the same appendages in the trek-oxen of Cape Colony, bear testimony to the facility with which developments in this direction can be encouraged.

Horn-development among domesticated cattle seems, however, to be restricted to increase in size, with some comparatively slight degree of modification in regard to general form and curvature; and it does not appear that any breed is known in which the horns are permanently characterised by an abnormality in structure.

Very different is the case in sheep, in which the horns seem to lend themselves with great facility to abnormal development in several directions. The typical form of horn is familiar to us in the wild sheep of Europe and Asia as well as in the old classical sculptures of Jupiter Ammon; and this type, although much reduced in size, is fairly well retained in the modern Dorset and merino breeds. In old rams of both breeds there is, however, a tendency to produce a spiral of greater length than ever occurs in wild sheep; and this tendency is perhaps even more noticeable in the mountain breeds of Scotland and Wales. In all the above breeds the original close and incurved horizontal spiral is, however, preserved. But in the so-called Wallachian breed of Eastern Europe the horns take the form of upwardly directed corkscrews, mimicking in fact to a certain degree those of the beautiful African kudu antelope. A single skull in the old Hunterian collection of the Royal College of Surgeons indicates the existence of a closely allied if not identical breed of sheep in Sumatra.

A far more curious modification produced by domestication is, however, displayed by the augmentation in the number of the horns; two, three, four, or even six extra horns being sometimes to be seen. When a pair of such additional horns are developed they usually occupy the upper and fore part of the head, and are of a more slender shape and take a more upright direction than the normal pair, which generally retain their ordinary position and form, although (as in the specimen here depicted) frequently showing a more or less pronounced lack of symmetry. When the Zoological Society possessed a farm at Kingston Hill, in the year 1829, several of these four-horned sheep were kept there; but, although llamas and alpacas, which are just as much domesticated animals, are exhibited at the present day in the Society's menagerie in the Regent's Park, four-horned and other abnormal breeds of sheep are not on show. Those curious in such matters may, however, see a fine four-horned ram from the Isle of Man recently presented to the British Museum by Mr. G. C. Bacon, and now exhibited among the series of domesticated animals in course of formation in the north hall. Here, too, may be seen a number of skulls, with the horns attached, of this remarkable breed, some of them coming from Iceland and others from as far east as China. Five is the maximum number of horns shown in any one specimen in this collection.

Bearing in mind the close affinity existing between sheep and goats, it is not a little remarkable that the additional horns developed in the four-horned breed of the former should approximate to a considerable degree

FIG. 1.—Four-horned Ram, the property of Mr. Cunningham, of South Uist, Hebrides.

both in direction and in curvature to those of the latter. This, however, must not be taken as an indication that the additional pair in the four-horned sheep represent the normal pair of the goats.

Some uncertainty still exists as to whether four-horned sheep belong to one or to several breeds, and also as to the place of origin of such breed or breeds, although they are known to be of very great antiquity. Report has it that one breed at least originally came from Iceland and the Faroe Islands, where they still exist, as they also do in the Orkneys, Shetlands, Hebrides, and the Isle of Man. The four-year-old forming the subject of our illustration is a Hebridean specimen, and was living in South Uist last year. Occasionally, it is said, the little brown sheep of the island of Soay, in the Hebrides, develop four horns, although they are normally two-horned.

Like the Soay breed, the Iceland four-horned sheep are of very small size ... colour, the fleece being not unfrequently a mixture ... patches of brown and white. The wool, too, as in ... all the inferior breeds of sheep, is much mixed with hair, so that it is by no means of a fine quality.

From the islands of north-western Europe four-horned sheep may be traced eastwards across the northern districts of continental Europe and Asia into China, where they appear to be comparatively numerous. Among the nomad Tatars, who are stated to possess considerable flocks of these sheep, the presence of four horns is associated with an enlargement of the base of the tail, owing to the deposition in that region of a large amount of fat. Although such a difference might be produced by crossing Icelandic four-horned sheep with the two-horned fat-tailed breed, it quite possibly indicates an altogether distinct breed. Moreover, Brian Hodgson, a former Anglo-Indian naturalist, in a paper on the tame sheep and goats of the Sub-Himalayas and Tibet, published in Vol. XVI. of the *Journal* of the Asiatic Society of Bengal (1847), states that the Huniya sheep of the Himalaya, which are white with black faces, occasionally develop four or more horns. Again, Darwin, in his "Animals under Domestication," mentions that merino sheep when exported to Chili display the same tendency. It would thus seem probable that there is more than one breed of four-horned sheep.

In most, if not in all, cases the two horns on each side of the head in these sheep are perfectly distinct and separate from one another at the base; but this does not prove that they may not in the first instance have originated by a splitting or division of the young horns of the normal pair.

In this connection it is very noteworthy that the antlers of deer are occasionally bifurcate for a portion or the whole of their length on one side of the head, although there does not seem to be an instance on record where such a feature occurs on both sides. That such duplicated antlers are due to a splitting during early development is rendered perfectly manifest by the head of a fallow-deer figured on page 855 of the *Proceedings* of the Zoological Society for 1896. In this instance it is the right antler which is double throughout its length, but instead of the two divisions of this antler being complete in every detail, the front one corresponds only with the fore half of the normal complete antler, and *vice versa*. Hence the proof of bifurcation.

On the other hand, in the three-horned red deer shown in Fig. 2 the duplicated antlers of the right side are practically replicas of one another; both being somewhat simpler than the normal left antler. In this case there is no evidence of bifurcation, but the three-horned fallow deer seems sufficient to demonstrate that the origin of the abnormality is the same in both instances. If this be the case, there seems no reason why the additional cranial appendages developed in the four-horned breed of sheep should not have been originally due to fission, although no trace of such original splitting can now be detected.

Splitting seems, indeed, to be a not uncommon mode by which abnormalities are produced. The museum of the Royal College of Surgeons possesses, for instance, the skull of a dog in which both the upper tusks, or canine teeth, are longitudinally split for about half their length. The splitting is clearly due to a partial fission of the crown of the tooth-germ. And it is not improbable that a similar fission carried to a greater extent may explain the condition obtaining in the skull of a fox recently exhibited by the present writer before the Zoological Society. In the case of this animal, which, by the way, was killed during the past winter by the

FIG. 2.—Antlers of French Red Deer, with Duplication on the Right Side. From a specimen in the collection of Viscount Powerscourt.

South Oxfordshire hounds there are two complete canines on each side of the upper jaw, one behind the other, giving a most remarkable appearance to the head. As already said, the complete duplication of the upper canine may quite possibly be an extreme development of the imperfect fission noticeable in the College of Surgeons specimen; but, on the other hand, it may be due to the growth of a supplemental germ which exists at the root of most mammalian teeth, but, as a rule, remains dormant throughout life.

To return to our sheep. It has now to be mentioned that the development of two or more additional horns in these animals is by no means the only abnormality which not unfrequently makes its appearance in connection with these appendages. There is, on the contrary, an equally marked tendency to "sport" in the opposite direction, that is to say to the coalescence of the normal pair so as to give rise to what are practically unicorn sheep.

These unicorn sheep have a much more restricted habitat than their many-horned cousins, being apparently confined to a certain portion of the Himalaya or Tibet, although they are not referred to by Brian Hodgson in his paper "On the Tame Sheep and Goats of the Sub-Himalayas and Tibet," already quoted.

Three specimens of the horns of this remarkable breed of sheep are known to be preserved in England, two of them being in the British Museum (to which they were presented by Hodgson), while the third is in the Museum of the Royal College of Surgeons, as the gift of Colonel Finch, in 1830. The latter is described in the Museum Catalogue in the following words:—"The horns have grown parallel to each other, and are firmly united throughout their whole extent, producing the appearance of a single horn, the extremity of which has been sawed off, probably to relieve the animal of the inconvenience of its pressure upon the neck."

Precisely the same description, inclusive of the sawing off of the top of the amalgamated horns, would apply to the two skulls of this breed in the British Museum.

In the case of the many-horned breed of sheep it would seem that the redundancy in horn-development is more probably a disadvantage than a benefit to the animals in which it occurs. And if, as seems to be the case, the amalgamated horn in the "unicorn" sheep tends to run into the neck of the owner so as to necessitate the amputation of the tip, the abnormality is altogether harmful; so that if it occurred in a state of nature it would probably soon disappear.

This amalgamation of the horns in the unicorn sheep presents a curious analogy to the so-called solid-hoofed pigs, which have been known from a very early period. "From the time of Aristotle to the present time," wrote Darwin, "solid-hoofed swine have occasionally been observed in various parts of the world. Although this peculiarity is strongly inherited, it is hardly probable that all the animals with solid hoofs have descended from the same parents; it is more probable that the same peculiarity has reappeared at various times and places. The peculiarity is produced by the welding together of the hoofs of the middle pair into a single large hoof."

Although we may at present be unable to explain the curious variations displayed by different organs among animals under domestication, this is surely no reason why we should neglect to study them at all.

THE STARS NEAR NOVA PERSEI.

FOR the accompanying photographs of Nova Persei and the surrounding stars we are indebted to Mr. A. Stanley Williams, of Brighton. Both were taken with a Grubb $4\frac{1}{2}$ inch portrait lens of about 20 inches equivalent focus, and have been enlarged to a little more than twice the original size. Mr. Williams has kindly furnished the following particulars with the photographs.

"No. I was taken on February 20th, with an exposure of 47 minutes; No. II on February 28th, with an exposure of 10 minutes. The latter is not a very good photograph owing to mist and fogging by moonlight, but, notwithstanding this, the apparition of the new star looks rather startling. Unfortunately, owing to cloud and moonlight it was impossible to secure a better one until the star had faded to a great extent. Although dated February 28th, the second photograph may be considered without serious error to show the appearance of the new star at the time of its discovery by Dr. Anderson on the morning of February 22nd (civil date), 28 hours after the first one was taken.

"The original negative of February 20th shows stars down to about 12th magnitude. The fainter stars are necessarily lost in reproduction, though in a successful copy stars down to about 11th magnitude ought to appear.

"The bright little star just above (north of) the new star, and almost exactly in the centre of the photographs, is 9th magnitude. It is BD. + 43° 739."

To this it may be added that the bright star near the edge of the field, on the right, is 30 Persei (magnitude 5.55), and that below it to the left is 32 Persei (magnitude 5.0). The bright star just below the north point of the field is 36 Persei (magnitude 5.55). The magnitudes quoted are on the Oxford scale.

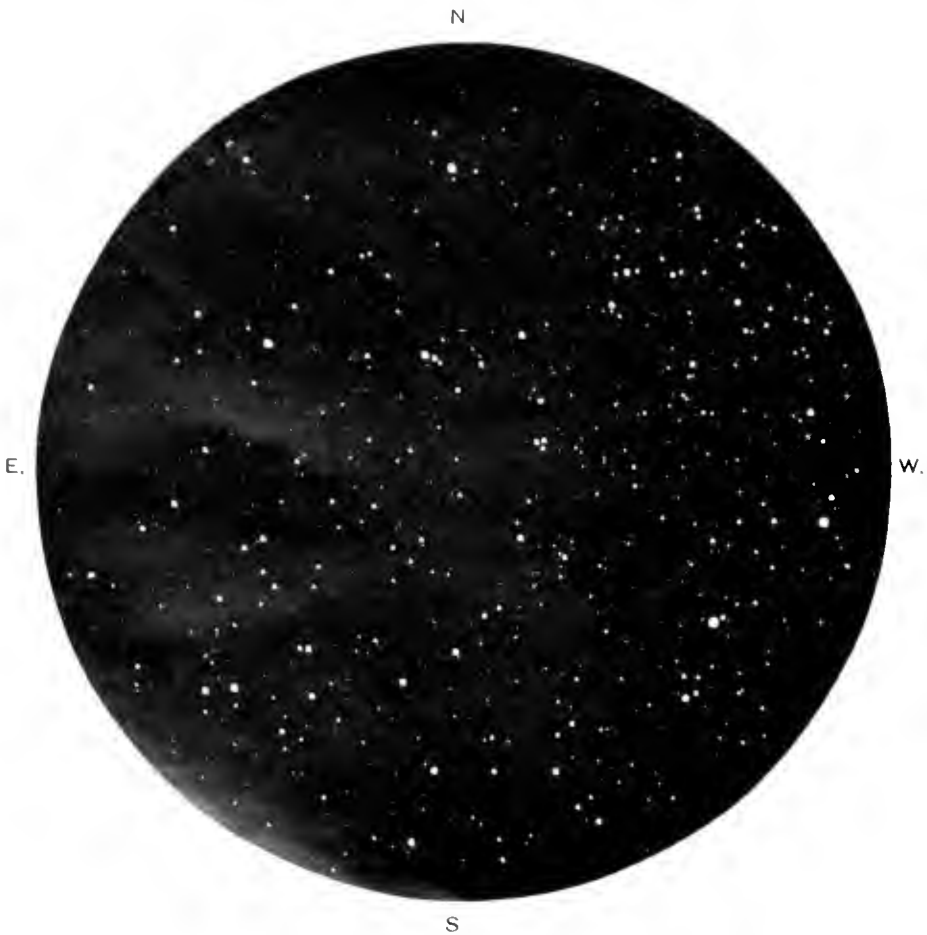
CONSTELLATION STUDIES.

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

VII.—THE SOUTH CIRCUMPOLAR STARS.

THERE is a strange, unforgettable sensation in the first voyage from our high northern latitudes to the southern hemisphere. Night after night the old familiar stars, the constant occupants of our sky at

NOVA PERSEI AND SURROUNDING STARS.



1900, February 20. 10h. 40m. to 11h. 27m.

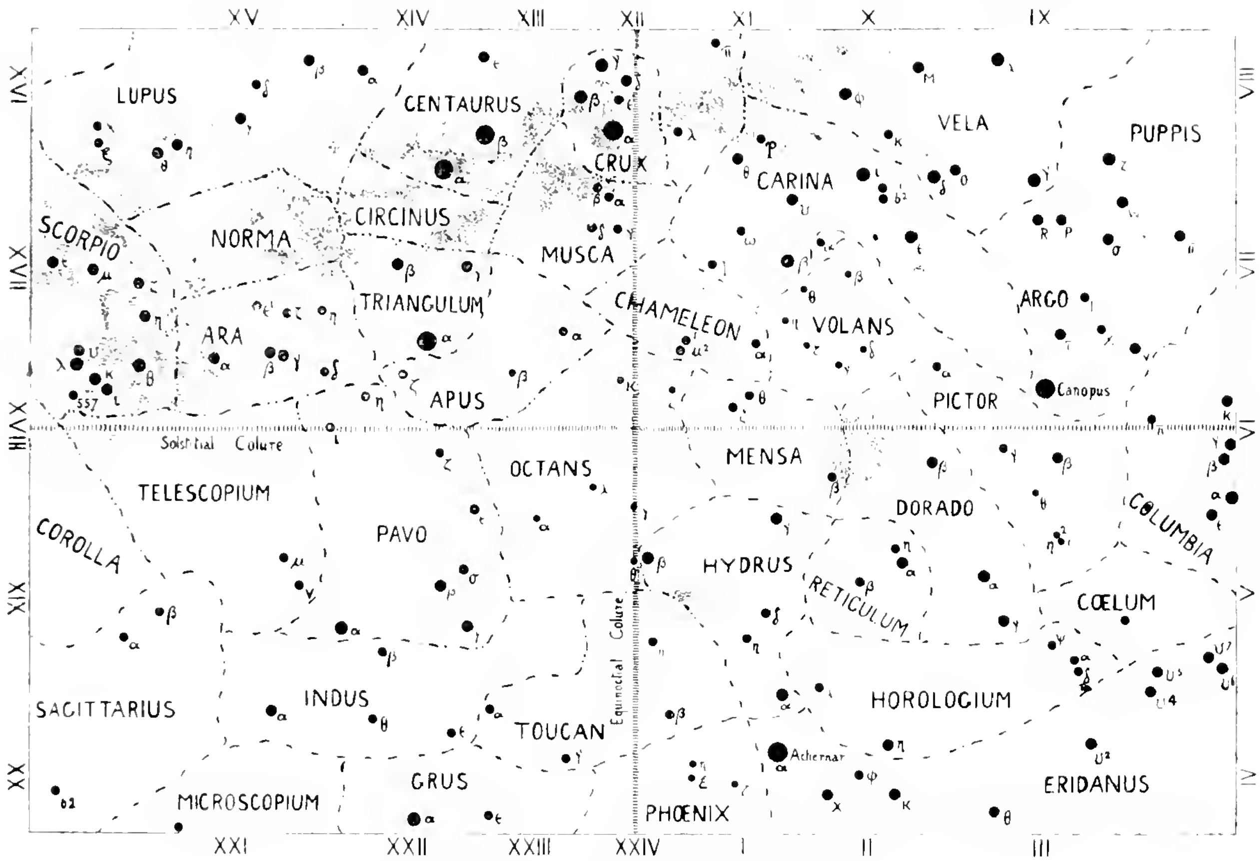
1900, February 28. 10h. 59m. to 11h. 9m.

From Photographs by Mr. A. Stanley Williams, taken with a 4½ inch Portrait lens. Nova Persei was not visible when the first photograph was taken, but appears as a bright star near the centre of the second picture.

home, sink lower and lower in the north and disappear, whilst new lights rise to shine upon us from the south. But beside the disappearance of old friends and the coming into sight of stranger stars, the known stars that still remain to us adopt most unfamiliar attitudes, and these become more and more perplexing the further south we go. Lordly Orion stands on his head in the exact attitude of a little city Arab, turning a cart-wheel; the long procession of the zodiac, all in turn suffer the same inversion; Pegasus alone, a topsy-turvy constellation with us, pursues his course across the sky with head upraised. Even the moon seems altered from the moon we knew in Britain; the mournful face that watched us there is no longer recognisable as such, since we see "his spotty globe" inverted.

The new regions of the sky opened to us from southern latitudes not only differ in detail from those with which we are familiar, they possess some general characteristics that cannot fail to strike the observer. Starting from Scorpio, here no longer creeping along the horizon as in England, but riding in the very zenith, we find the Milky Way sweeping downwards towards the south-west in masses of the greatest brilliancy and complication. Around its course are gathered the greatest aggregation of brilliant stars to be found anywhere in the sky. The Scorpion is followed by the Wolf and the Centaur, and these by the ship Argo. Between Argo and Centaurus comes the little Southern Cross, a constellation which has perhaps been extravagantly praised, but which yet contains within a very small area three stars above the second magnitude, and six others ranging between that and the fifth. The Centaur claims ten stars brighter than the third magnitude, the Wolf three, Argo fifteen, one of which Canopus is inferior only to Sirius. As the Milky Way sweeps through Argo, it enters Canis Major, which, though not a large constellation, contains Sirius and three stars above the second magnitude and three more above the third. This belt of the sky, therefore, from Scorpio to Sirius, is by far the most brilliant in the entire heavens, both from the numbers of brilliant stars clustered within a narrow band and from the brightness of the Milky Way. But beyond this belt we find an altogether different state of things. Round the southern pole there are no star groups to rival the Great Bear, Cassiopeia, the Dragon, or even Cepheus and the Lesser Bear, which surround the northern pole. The new constellations, which were placed round the southern pole by Dircksz, Keyser, and Lacaille, are for the most part entirely destitute of bright stars, or of easily remembered configurations; those actually round the pole being especially poor in this respect. Octans, the constellation in which the southern pole is situated, though of considerable extent, contains but a single star as bright as the fourth magnitude, nearly all its members being fainter than magnitude 5½. The southern pole star, Sigma Octantis, is catalogued as of magnitude 5.8.

The other chief features special to the southern heavens, are the presence of the two Magellanic Clouds, to which there is nothing to correspond in the northern sky. Then close to the Southern Cross, we find the Coal Sack, a great hole in the Milky Way, blacker and much more defined than any corresponding gap in its northern course. There is indeed a "coal sack" in the constellation of the Swan, but the portion of the Galaxy surrounding it is far from being so bright and distinct

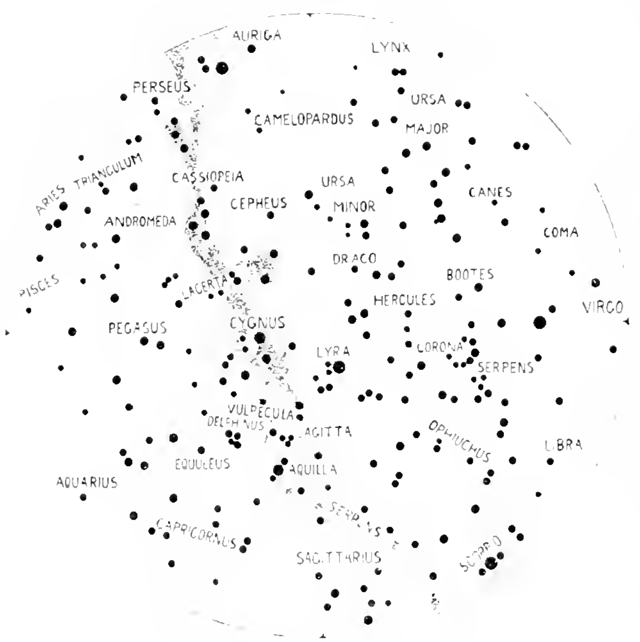


Star Map No. 7: The South Circumpolar Stars.

as that which hems in this curious island in the great celestial river of light. Lastly the southern heavens generally seem much richer in stars just within the ordinary range of vision than the northern, the barren circumpolar region being almost surrounded by a broad belt, especially rich in the regions of Eridanus and Argo, in which sixth magnitude stars are to be found in unexampled abundance.

For Cape Town and the colonies of Victoria and New Zealand, the Southern Cross is a circumpolar constellation, always above the horizon, and at midnight on March 28th it stands vertically above the south pole, Canopus being then on the same level as the pole and west of it, whilst Alpha Eridani, Achernar, "the end of the river," almost touches the horizon in the south. At the present time of the year, the Cross at midnight is at the same elevation as the south pole but west of it, balancing Achernar at the same distance on the east; whilst Canopus is below the south horizon for South Africa, but just visible for Tasmania and South New Zealand.

These great leader stars enable the general trend of the southern constellations to be easily made out. When the Cross is seen erect, the foot of the Cross is marked by Alpha, the head by Gamma, and the Cross



The Midnight Sky for London, 1901, July 1.

beam by Delta and Beta, Beta being much the brighter of the two. Moving from Delta through Beta, we come at no great distance to the first magnitude star, Beta Centauri, and Alpha Centauri lies but a little further on, almost on the same straight line. Nearly midway between Canopus and Alpha Crucis lies Beta Argus, a star but little below the first magnitude. Not far from Beta is the False Cross, four stars, in a trapezium, not quite so bright and a little more widely spread than those of the true Cross. Epsilon Argus forms the foot, Kappa the head, and Delta and Iota the cross-beam.

The many obscure constellations which have been formed in this region may now be pretty easily picked up.

Between Octans, which surrounds the south pole, and the Southern Cross, we have Chamæleon and Musca; close to Beta Argus is Volans, the Flying Fish; Pictor lies by the side of Canopus; the Greater Magellanic Cloud borders on four constellations, Mensa for "Table Mountain," Dorado, Reticulum and Hydrus; the Lesser Cloud lies between Hydrus and Toucan. Five constellations meet round Achernar; Eridanus a primitive constellation; Horologium and Phœnix; and the two just mentioned, Hydrus and Toucan. Passing over to the Southern Cross, the Milky Way between that constellation and the Scorpion sweeps over the feet of the Centaur and six other constellations beside,—two of them primitive. The three constellations immediately below the Scorpion are Lupus, Norma and Ara, of which only Norma, placed in the middle of the Milky Way, is new. Circinus below Norma, and the Southern Triangle below Ara are both new, as also is Apus, which lies between them and Octans. The Southern Triangle is a neat little figure on the edge of the Milky Way, its three principal stars making a diamond with Alpha Centauri. Alpha, the brightest star, and the one furthest from the Centaur, lies midway between Alpha Crucis and Alpha Pavonis, a second magnitude star, the brightest of Pavo, a constellation much brighter than any of the new constellations we have yet noted, and one covering a considerable portion of the zone of small stars to which allusion has already been made. Indus, a fainter constellation, lies between Pavo and Toucan, and completes the band of small asterisms surrounding Octans.

PROF. ADAMS' LECTURES ON THE LUNAR THEORY.*

By P. H. COWELL.

PROBABLY few courses of lectures have enjoyed as great a reputation as those which Professor Sampson, after including them among the collected papers of Professor Adams, has now published in book form. The lectures deal with the most interesting of all problems of applied mathematics, and at the time of their delivery they formed the only adequate attempt to present the subject to a student in a form so that, while a comprehensive view of the whole subject is achieved, numerical labour is as far as possible avoided. As Professor Sampson says, several treatises exist that are intended to form the basis of tables in which completeness is the first object and manner of presentation the secondary. During the period 1860-1889, when Professor Adams was lecturing on the subject, there were in existence elementary theories, of which Professor Sampson truly says that they leave off when the difficulties of the subject begin, that is to say, the various cases of slow convergence have been exposed and not dealt with. To present the same idea in slightly different language: It is conceivable that a computer might repeat the whole of the calculations of a lunar theorist, and verify his numerical accuracy (or detect his errors, as the case may be), and at the end of his work, which would probably take quite ten years, he might not have a clear geometrical conception of what he had been doing. Again, one of the elementary treatises referred to might awaken in a reader some faint glimmering of the

* Lectures on the Lunar Theory, by John Couch Adams, M.A., F.R.S., late Lowndean Professor of Astronomy and Geometry in the University of Cambridge. Edited by R. A. Sampson, M.A., Professor of Mathematics in the University of Durham. (Cambridge: At the University Press. 1900. London: C. J. Clay and Sons.)

nature of the subject, but it would hardly place him in a position to carry on the calculations for himself to the accuracy required for forming tables. Adams to a great extent achieved success in a middle course. He divided and got the mastery of his subject. He left on one side those higher approximations that involve merely labour in computing, and illustrate no principle, but he pushed the lower approximations to a high degree of accuracy, and not merely showed how to obtain, but actually did obtain numerical values for the principal parts of the motions of the node and apse and the co-efficients of the principal inequalities. The great value of his lectures may be illustrated by the fact that when ill-health compelled Adams to cease lecturing shortly before his death, notes of his lectures were borrowed and copied by the younger generation. Professor Sampson was fortunate to be among the last that attended the course, the present writer was among the first to make a copy.

The lectures were last delivered twelve years ago, and were constantly revised during the whole period in which they were delivered. And yet they are already, and have for some time been, to a great extent out of date. The last two chapters of Adams' lectures deal with Dr. Hill's methods. These methods have since been developed by Professor Brown, and made the basis of lectures in Cambridge by Professor G. H. Darwin. The concluding portion of this notice will be to attempt to explain the points of superiority of Hill's method over all that preceded it.

Any co-ordinate of the moon, that is to say, its longitude or its latitude, or its radius vector, or the projection of its radius vector in any direction, may be developed in a series of periodic terms, whose arguments are the sums of any integral positive or negative multiples of four fundamental angles that increase uniformly with the time and at rates that are incommensurable. The immense complexity of the problem may be conceived by imagining four piles of coins of incommensurable value. One pile, we may suppose, consists of sovereigns, and, in addition, "negative" sovereigns, that is to say acknowledgments of debt to the extent of a sovereign; the other piles are to consist of francs, marks, and krönes with corresponding "negative" coins, or acknowledgments of debt. Then for every sum of money that can be made up from these coins, there is a periodic term in the lunar co-ordinate, and if not more than seven to twelve coins are used to make up the sum, then the co-efficient of the corresponding term in the lunar theory is important enough to be calculated. In addition a very great number of these co-efficients are large and correspondingly difficult to calculate, for the same reason that a very slight muscular effort, constantly repeated at regular intervals, will set a swing into violent oscillation, or that a ship that remains moderately steady in some seas will roll violently in others when the interval between one wave and the next happens to be of a certain length.

Now if this illustration has given any idea of the gigantic nature of the task, it will be clear that it will be a great convenience if the theory is such that the terms can be calculated in groups of a small number at a time, first one group and then another group, just as Nature builds up a living organism by "epigenesis," or the adding of one cell to another cell. When this can be done, another stage can be added at any time, should it be considered convenient to do so. When it is not the case, not only is the labour much increased, but it is nearly impossible to extend the work to approximations higher than those at which the original computer left it. This criterion is a condemnation of Delaunay's theory, which, while it is in many ways the most elegant from the mathematician's point of view, has probably proved the most laborious of all in its computations, and has nevertheless not been pushed to such accuracy as might have been desired. But in this respect both the theory adopted by Adams and that propounded by Hill leave nothing to be desired.

Both Adams and Brown (who is working out Hill's theory) divide the terms into groups. Now there is only one way of dividing into groups, and the first group of terms constitutes what is called the variation, which is an inequality in the moon's motion that goes through its period in half a synodic month. Now Adams and all the theorists before Hill start by pointing out, that owing to its immense distance the sun's influence is very slight, and if it could be neglected altogether the moon's orbit would be an ellipse. Then it is found that although the sun's influence is slight, yet in some respects it is cumulative and not periodic, and hence we have a rotating ellipse introduced to our notice which, doubtless, is a very convenient geometrical representation of the moon's path, but it is hardly a good "intermediate orbit" or first approximation for a dynamical calculation, since it does not represent an orbit that would result from an approximation to the actual forces that govern the path of the moon. Now Hill takes the first terms that are calculated—the variation—and interprets them dynamically. These terms and these terms only represent a possible path for the moon that could correspond to the actual case of Nature, with one modification: the sun must be supposed to be at infinite distance, while retaining influence enough upon the earth-moon system to maintain the length of the year at its present value. The next group of terms to be selected for calculation (for although the grouping is determinate, there is a little choice as to the order in which the groups are to be taken) may modify the orbit (by adding what are known as the parallactic inequality, because it only exists in consequence of the sun's parallax not being zero, and the annual equation due to the ellipticity of the earth's orbit round the sun) into an orbit that the moon might pursue, only it happens not to do so. And then the rest of the work consists in this only: the moon is considered to oscillate in two ways about the above-mentioned orbit that it might pursue: in the first place it does not remain in the plane of the ecliptic but oscillates from side to side of it; in the second place it keeps crossing and recrossing the orbit it might pursue. The size of these oscillations must be determined by observation, for, as has been pointed out, they need not exist at all, and their size is subject to no conditions, and might have been anything including their actual values or zero. Moreover, the periods of these oscillations must be determined by calculation, and the lunar theory is then complete.

Calculation shows that the periods of these oscillations are neither of them exactly a month; and, therefore, to confine our attention to the oscillation across the plane of the ecliptic, the node or point of crossing is not the same in each revolution or in other words, the node revolves. This is not contrary to expectation; the surprising thing would have been if the period of oscillation had turned out to be exactly a month; and it leads to no inconvenience, such as in the older theories, when it compelled the introduction of rotating ellipses with no dynamical interpretation.

We conclude with another example of the advantage of treating the eccentricity and inclination as oscillations. It is well known that as long as the arc of vibration of a pendulum is very small, the period of its oscillation remains constant, but when the arc of oscillation is increased, the period of its oscillation is altered by terms depending on the square and higher even powers of the arc of vibration. Now this is one of the simplest dynamical problems to work out, just as the lunar theory is one of the most difficult; but the analogy holds exactly, for the principal term in the motion of the moon's node (or apse) is independent of the size of the oscillations that is to say, the moon's node would still revolve in about nineteen years even if the eccentricity or inclination were double or half what they are; but the smaller terms in the series that give the motions of the apse and node contain squares and higher even powers of the amplitudes of the two oscillations.

Letters.

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

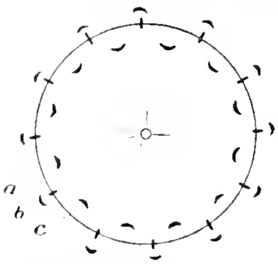
THE ORBIT OF THE MOON.

TO THE EDITORS OF KNOWLEDGE.

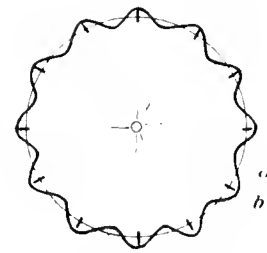
Sirs,—The present communication is intended to fill a gap which exists in all the popular books on astronomy. All those which I have seen contain nothing or little to enable the reader to obtain any idea of the courses of the moon in the heavens. For many years it was a puzzle to me, as it was to others, for I have never yet met with any one, except those who had a professed knowledge of astronomy, who was able to describe in an intelligible manner the course which the moon took in its circuit round the earth and sun.

I was once at the sea-side with a gentleman who had just taken a University degree for which he had to pass an examination in natural science, and we got on the subject of the tides and moon; he declared that he had not the remotest idea how the moon took its annual course. I therefore asked him to stand at a fixed distance from myself to represent the moon as I would the earth, and to hold his stick behind him as I was doing to trace our course on the sand as we walked on. Keeping his distance as if tied to me he was to walk quicker or slower, and thus he would be necessarily revolving around me, whilst at the same time he was moving forward. His movement would not be in circles but in curves. This demonstration being on a plane is of course so far imperfect.

The subject has of late come before me again when some young people during the Christmas holidays attended a lecture on the moon. They were shown the moon's phases in the usual manner by making it perform a circle round the earth, although this explained the varying phases of the moon they saw for themselves that no such circle could really exist unless the earth were stationary. I made this more intelligible to them, as I have done to others, by drawing the two figures pictured below. I made a circle for the earth's orbit with the sun in the centre, and divided it into twelve monthly parts for simplicity, thirteen being an awkward number to deal with. I then made twelve marks opposite the different divisions to indicate the twelve full moons. This forms the outer circle. My young friends assented to it as correct. They also assented to my making twelve marks between these constituting the inner circle corresponding to the no moon or dark moon. It was now obvious that if these marks were correct the luminary must pass from one to another during the fortnight between them; these, therefore, I joined, and the course of the moon was at once seen. I have heard persons



a.—Earth's orbit.
b.—Outer circle of full moons.
c.—Inner circle of no moons.



a. Orbit of Earth.
b.—Orbit of Moon made by joining the points.

who have taken some little interest in the heavens declare that this simple drawing was a complete revelation to them as they were so beset with the idea of the circular movement of the moon as portrayed in the books that they could not eradicate it from their minds. As before said this diagram is on a plane, and, therefore, imperfect; but a better demonstration may be made by taking a coil of wire such as is used in electric instruments, bending it into a circle and joining the two ends. When stretched out so as to elongate the coils the spiral may be regarded as showing more correctly the course of the moon.

It must be also remarked that in my diagram there is no attempt at proportion, for it would be impossible to draw on so small a scale a spiral so close to the earth's orbit as to be 400 times less distant from it than the space between the earth and the sun.

Let me finally say I am no astronomer or mathematician, and, therefore, have no pretence to tread on their ground; all I advance for myself is the fact that there being no account of the course of the moon in popular books, the reader being left in ignorance of this subject or often misled, I have found my description and drawing have made it intelligible to them, although of course in a very rough and imperfect way.

Samuel Wilks.

P.S. Whilst inserting my letter the Editors inform me that there are astronomers who have fully discussed the question of the moon's path, and have raised objections against the description which I have given, more especially as from mathematical reasoning this path is everywhere concave to the sun.—S. W.

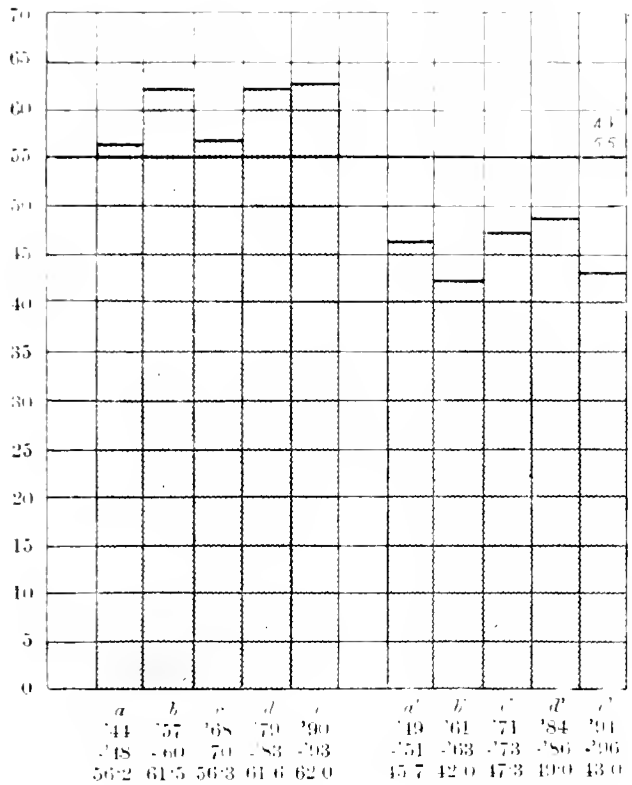
[The defect of the diagram to which Sir Samuel Wilks' attention was called lies in the simple fact that it is not drawn to scale, and consequently represents the path of the new moon as convex to the sun instead of concave. This concavity should not be difficult to comprehend if it be borne in mind that even at the time of new moon the chief motion is that of revolution round the sun, which it has in common with the earth. The velocity of the moon in its orbit round the earth only amounts to 3000 feet per second, while its average velocity in its motion round the sun is 18.6 miles per second. Eds.]

SUNSPOTS AND WINTERS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The accompanying rough diagram I would offer for criticism:—*a*, *b*, *c*, *d*, *e*, each shaded column represents the average number of frost days per winter at Greenwich, reckoning from September to May, during growth of spots (first winter after minimum, to winter ending in maximum year). *a'*, *b'*, *c'*, *d'*, *e'*, the same in three winters following maximum. The one set are all *above* average, the other all *below*.

ALEX. B. MACDOWALL.



DETERMINATION OF NOON

TO THE EDITORS OF KNOWLEDGE.

SIRS,—We live in a rather isolated district and, as we have no sun-dial, find it difficult to get accurate time. Is there any simple means, by the shadow of a pole or building, by which we could tell exactly when it is noon? Any suggestion you can give us in this matter will be thankfully received. WM. DAVIES

Concord, Dominica,
British West Indies,
April 24th, 1901.

[The exact determination of time requires the use of instruments, but the approximate time of noon may be ascertained by watching the coincidence of the shadow of a vertical rod with a meridian line drawn on level ground from the foot of the rod. The meridian line is usually formed by drawing a portion of a circle through the end of the shadow some hours before noon, with the foot of the rod as centre, then marking the point on the circle where the tip of the shadow reaches it in the afternoon, and joining the middle of the arc thus formed with the foot of the rod. Several circles should be drawn, and the mean of the positions should be adopted. Noon determined in this manner will be local apparent noon, and correction must be made for the question of time in order to find the local mean solar time which should be shown by a watch. Several suggestions for observing the sun were made by Mr. Maunder in KNOWLEDGE for June 1900, p. 133.—EDS.]

CLOUDS ON MARS

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Your correspondent, Mr. E. Lloyd Jones, has, in the April and June issues of the magazine, stated some objections to my previous communication (February). I fear I stated the question rather bluntly when I said, "The atmosphere of Mars is thin and consequently free from cloud." What I meant at the time of writing was that the clouds on Mars are so rarely visible that they are scarcely worth recording. Mr. Jones will find that this is the view of almost all our modern astronomers. As I stated before, my views on the subject have largely been gained from Mr. Percival Lowell's book on "Mars," and should Mr. Jones desire further information I would refer him to this work. T. R. WARING.

Liverpool.

THE ICE AGE

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Some years ago you inserted letters of mine on the subject of the Ice Age. I hope the following additional remarks may also find a place in your columns.

The late Prof. Tyndall stated that what was required in order to account for the Ice Age was a better distilling apparatus than at present. But this remark cannot be adopted without qualifications; for with a better distilling apparatus the aqueous vapour might be deposited in the form of rain, not snow. And, in fact, the Ice Age seems to have been succeeded by a Rain Age, for I do not think that the melting of the snows will account for the very large amount of water which seems to have been then deposited on the land. The Ice Age and the Rain Age seem to have resulted from increased distillation under different circumstances.

Air at a high temperature may contain much moisture but it can hardly be deposited as snow. Air at a very low temperature contains very little moisture, and can hardly produce a snow-cap of any considerable depth. A heavy snow-fall only occurs when the temperature is little below freezing-point, but to produce such a heavy snow-fall two further conditions are requisite: first, that the fall of temperature should be rapid, and secondly that the air should be moist. The latter condition in these regions requires that the wind should be from the W. or S.W.; or at least that the conflict between the wind and one from the opposite quarter should take place over this country before the temperature has sunk too low.

We then require a rapid fall of temperature at a time when the mean temperature is near freezing-point and the air is moist. If the rapid fall takes place before this period of the year there will be a rain-fall not a snow-fall. If later the snow-fall will not be so heavy.

The fall of temperature dependent on the seasons does not vary with the eccentricity of the earth's orbit. The most favourable condition for the formation of a snow-cap at any particular place will, therefore, be that the sun's distance should increase most rapidly at the time of the year when the mean temperature is nearly at freezing-point. I mean, of course, *before* the winter. For when a similar state of things occurs in spring a rapid increase in the distance of the sun would be balanced by a like increase in the length of the day and of the sun's meridian altitude. Suppose then that we take a country in which the mean temperature sinks to freezing-point about the middle of November, an Ice Age would be most easily formed when the eccentricity of the earth's orbit was at a maximum, and the earth was in aphelion about the middle of August. This would be the period at which the cap would form most rapidly, but it would no doubt continue to increase in mass for some time afterwards, and the most extensive cap might be found to correspond with an aphelion not at midsummer but at the autumnal equinox.

I am not at present considering the competence of the cause assigned by Dr. Croll for the Ice Age in the British Isles. I am only dealing with the date of the aphelion which would be best adapted for the formation of a snow-cap. Even with the present small eccentricity of the earth's orbit the periods of greatest heat and greatest cold are very perceptibly later than the longest and shortest days. With a more eccentric orbit this difference would probably be increased and the mean temperature of England might not fall to freezing-point until a much later date than at present. But whatever this date might be, it is the date at which the sun's distance should be increasing most rapidly in order to produce a lasting snow-cap.

W. H. S. Monck.

NOTES.

Astronomical.—It is reported that the Harvard College Observatory astronomers, who have been at work in Jamaica, have obtained photographic evidence of the existence of snow on the surface of the moon. Details have not yet been received, but it is stated that changes have been detected on many of the mountain peaks, and the simplest supposition is that the variable substance is snow.

Further reports on the eclipse of May 18th state that good photographs of the corona were obtained by both Mr. Newall and Mr. Dyson, and that Mr. Newall also obtained good results with his grating spectroscope and polariscopic camera, but failed to establish the rotation of the corona. The brightest parts of the corona showed marked polarization. Prof. Barnard's long exposure photographs were unfortunately spoiled by clouds. Count de la Baume Pluvinel, who also observed in Sumatra, appears to have been pretty successful, though he did not succeed in demonstrating the rotation of the corona; no Fraunhofer lines were detected in the spectrum of the corona.—A. F.

Botanical.—The report of the Departmental Committee on botanical work and collections at the British Museum and Kew, together with minutes of evidence supplied by a number of eminent British botanists, has been published in the form of two Blue books, which contain matter of very considerable importance to all botanists. The Committee was appointed "to consider the present arrangements under which botanical work is done and collections maintained by the Trustees of the British Museum, and under the First Commissioner of Works at Kew respectively; and to report what changes (if any) in those arrangements are necessary or desirable in order to avoid duplication of work and collections at the two Institutions." The recommendations of the Committee are in favour of the union of the two herbaria, and of their being united at Kew, where suitable accommodation would have to be provided for them. It is considered advisable, however, that the fossil plants and the botanical objects exhibited to the public at the Natural History Museum should be maintained, the latter feature to be extended and developed as much as possible.—S. A. S.

Entomological.—The subject of sound-production by insects continues to attract the attention of naturalists. A valuable paper on "The Stridulating Organs of Waterbugs" has been contributed to the current number of the *Journal of the Quekett Microscopical Club* ((2) VIII., pp. 33-46, pls. 3-4) by Mr. G. W. Kirkaldy. He deals principally with the musical performances of the Corixidæ. These little insects make a shrill chirping note, which has been attributed by several previous observers to the action of a "comb" of regularly arranged teeth on the front foot. But Mr. Kirkaldy maintains that this comb is drawn, not as previously supposed, across the edge of the face or beak, but across a special spiny, stridulating area on the opposite front thigh. The arrangement of the teeth of the "comb" varies characteristically in the different species of waterbugs, and Mr. Kirkaldy believes that the elaborated forms of the organ can be derived from the simple row of bristles found on the foot of the tiny Micronecta or Sigara. The fully-developed musical instruments are confined to the male sex. Another important paper on this subject has been lately published by Dr. A. Handlirsch (*Ann. Hofmus. Wien.*, XV., pp. 127-141, pl. 7), who describes also stridulating organs on the thoracic segments of Reduviids and other land-bugs.—G. H. C.

Zoological.—Mr. Lydekker's article on "Mammoth Ivory," which appeared in Knowledge for July, 1899, has been republished in the *Smithsonian Report* for 1899, now just issued.

In the June issue of the *Proceedings* of the Zoological Society of London, Dr. W. G. Ridewood discusses the structure and origin of the so-called "bonnet" of the southern right whale. This is a large horny excrescence, worn into hollows like a much denuded piece of limestone rock, growing on the head of this particular kind of whale probably in the neighbourhood of the blow-hole. More than one somewhat wild theory has been suggested to account for its presence. One suggestion is that it indicates the descent of whales from rhinoceros-like mammals; another that this species of whale is in the habit of rubbing against rocks in order to free itself from barnacles, and thus produces a kind of corn—although why on the nose alone is not stated! Dr. Ridewood will, however, have nothing to say to these ideas, but considers that the structure is due to the fact of the horny layers which are produced all over the skin are not shed on this particular spot. This is satisfactory so far as it goes, but we still want to know the reason for the local retention of these layers and their growth into a kind of horn.

The brief description of the little known *Equus przevalskii*, as represented by a mounted specimen in the museum at Paris, in the same journal, cannot fail to be interesting to naturalists. Apparently it may now be taken as certain that the animal in question is really a distinct species, and that in some respects at least—notably the presence of "chestnuts" on all four limbs, it is more nearly related to the horse than to the asses.

The origin and evolution of the Australian marsupials are discussed at some length by Mr. B. A. Bensley in the April number of the *American Naturalist*. In broad contrast to the views of Dr. Wallace, the author is of opinion that marsupials did not effect an entrance into Australia till about the middle of the Tertiary period; their ancestors being probably opossums of the American type. They were then arboreal; but they speedily entered upon a rapid, although short-lived course of evolution, during which leaping terrestrial forms like the kangaroos were developed. The short period of this evolution is at least one factor in the primitive grade of even the most specialized members of the group. In the advance of their molar teeth from a trituberculur to a grinding type, the author traces a curious parallelism between marsupials and placentals. Taking opossums to have been the ancestors of the group, the author considers that Mr. Lydekker may be right in his view that marsupials entered Australia from Asia by way of New Guinea. On the other hand, there is nothing absolutely decisive against their origin being southern.

In the May issue of the same journal Dr. H. S. Jennings shows that the spiral revolution of many small swimming organisms is analogous to the revolution on its own axis of a rifle-bullet, namely, in order to render them capable of maintaining a straight course.

The degree of Doctor of Science has been conferred upon Mr. Vaughan Cornish by the Victoria University, Manchester, in recognition of his investigations upon waves and kindred phenomena.

Notices of Books.

"Advanced Exercises in Practical Physics." By Prof. Arthur Schuster, Ph.D., F.R.S., and C. H. Lees, D.Sc. (Cambridge University Press.) 8s. Illustrated.—It is surely an objection for a book which is to be used in a laboratory to be sent out with uncut edges, and we take this opportunity of suggesting to publishers the desirability of cutting the edges of such manuals. The present book is a laboratory guide for students who, having already had some experience in practical physics, are taking up the subject for the examination for the degree of B.Sc. The course includes seventy-five different exercises, and is therefore fairly extensive. It apparently has been difficult for the authors to know exactly how much "theory" to give in this book as an aid to the working of any particular exercise. Sometimes this aid is unnecessarily full, and at other times too slight. The account of errors of observation is good. The drawings are not very plentiful; we may suggest one at least which might be useful in a new edition of the work, viz.: The method of supporting a specific gravity flask in a water bath by rubber bands. Incidentally we may remark that the capacity of this bottle is referred to on page 62 as its volume. The account of methods of accurate weighing is very well done in this section, and the mode of entering complicated notes is made clear by several examples. It is noticeable that no use is made of films in the work on Surface Tension. In the experimental work on linear expansion more detail in the drawing of the apparatus would be useful to teachers, who on reading the book will be sure to want to use the method there given. The apparatus for the measurement of expansion of a gas seems to be very well thought out, and the same remark applies to that used for the latent heat of steam. In the sections under the heading Acoustics, only three experiments are described. The sextant is dealt with at length under Optics, and the great value of the instrument insisted upon—an important point for those engaged in arranging practical courses. In the portion of the work devoted to Electricity a very full account is given of the adjustment of mirror galvanometers. This is sure to prove of great value to the student. Mance's method for internal cell resistance is replaced by Lodge's modification. We confess to liking so much of the contents of this book that regret is felt more has not been included. The standard of accuracy aimed at in the early part of the book seemed to preface an almost cyclopaedic course of practical work. It is hence with a certain disappointment that we find platinum thermometers [illegible] Notwithstanding this, the book will be [illegible] by both teachers and students.

"The Self-Educator in Botany." By R. S. Wishart, M.A. Edited by John Adams, M.A. [illegible] (Hodder & Stoughton.) Illustrated. 2s. 6d. As [illegible] introductory note, the object of the series to which this work [illegible] addition, is indicated by its title. The Self-Educators [illegible] hoped that by means of these books the most isolated student will be able, without other aid, to ground himself in the various subjects dealt with." The first chapter deals with germination, and is followed by others, treating of root, stem, and leaf. Chapter II. bears the somewhat fanciful title of "Plant life, manners, and morals," and includes detailed instructions for carrying out experimental investigations into various physiological phenomena, some of which are by no means easy when conducted in a well-appointed laboratory, and under the advice of an experienced investigator, and are, we fear, destined to afford little but disappointment to the isolated, unaided, and untrained student. We are told in a section of this chapter, entitled "Intelligence and Selfishness," that many plants "show a sagacity and foresight not to be despised," as instances of which we have the twining of the stems of convolvulus and hop, and the movements of stamens, the secretion of nectar, and the dehiscence of the pods of some other plants, and we are further informed that "many instances of scheming and contrivance will thrust themselves upon the observer's notice." The author, doubtless, does not intend these expressions to be taken seriously, but it is surely unwise to introduce ideas of this kind, in any form, to the mind of the beginner, by whom the author's light vein may be entirely misunderstood. Further chapters deal with the inflorescence, the flower, and fertilisation and its results. Part II. is concerned with the classification of plants, and although we cannot approve of its arrangement, it will perhaps be found useful by the student who is not yet familiar with the characters of the natural orders. On the last three pages are given hints to the plant collector, and the titles of a few useful text-books for further study. The author states in his introduction (p. xi.) that "There are many wrong ways of studying botany. . . . But the right method, whatever else it includes, must include the principle of beginning in the field, if possible, and, in any case, with actual plants as wholes, and then proceeding to laboratory work." With this sound principle we fully agree, and a book designed to teach the first principles of botany, particularly if it is to justify the title "self-educator," must be written upon these lines, or fall very far short of what it ought to be. There can be no doubt that the volume before us is not prepared in accordance with the view thus expressed by the author himself. If the author had impressed upon his readers the necessity for constant field work, and the use of the British or county flora, and had introduced the student to a consideration of living plants before going into the more technical matter which composes the bulk of his work, we think he would have rendered a far greater service to his readers, and come much nearer to achieving his own object. The somewhat diagrammatic figures are badly reproduced, but have the excellence—unusual in text-books of botany—of being original.

"A Manual of Elementary Science." "A course of work in Physics, Chemistry, and Astronomy, for Queen's Scholarship Candidates." By R. A. Gregory, F.R.A.S., and A. T. Simmons, B.Sc. (Macmillan.) 5s. 6d. The scope of this book is to a certain extent defined by the sub-title, but it may be stated at once that the use of the term "work" is fully justified by the contents. Whenever possible, work of some sort is made to precede mental exercise, and as the authors remark, "This is the scientific method . . . to show that the principles, rules, and relationships constituting natural knowledge are records of experience and not matters of opinion." In the sections on Physics and Chemistry, novelties in the way of simple experiments are frequently introduced. While both these sections are admirable, that on Astronomy is of special interest on account of the praiseworthy attempt which is made to extend laboratory methods in the study of this subject. The student is taught how to appeal to the heavenly bodies, and if he has no instruments, he is told how to make them. Particularly to be commended is the simple form of altazimuth described on p. 370, though strangely enough the authors have not made quite clear to the student what excellent opportunities the possession of such an instrument would give him. It is shown how many astronomical phenomena can be elucidated by easy experiments, and the use of squared paper in connection with an almanac is introduced with excellent effect. Work is thus provided for cloudy as well as for clear days and evenings, and if there should be an undue proportion of the former the student may profitably occupy himself in working some of the interesting examples which are given. The book is admirably illustrated, and deserves to find a large circle of students outside the class for which it appears to have been specially prepared.

"The Microscopy of the more commonly occurring Starches." By Professor Hugh Galt, M.B., C.M., D.P.H. (Baillière, Tindall & Cox.) Illustrated. 3s. 6d. net. This is an unpretentious little volume with the aims of giving the analyst, student, and others who may have to examine materials for adulteration, etc., a basis on which to [illegible]. For this purpose a number of photographs have been taken [illegible] of the [illegible] and reproduced in the book with the magnifications [illegible] exactly stated. Starch grains are peculiarly [illegible] from a photographic standpoint, [illegible] markings by which the student is usually directed do not appear conspicuously in the photographs. We are not sure that the [illegible] medium that was used in the specimens is the best [illegible] have often found that the details of such subjects are better displayed [illegible] some media than in others. Still the bases for working and [illegible] are sound, the contours and sizes of the various starches are at once apparent, and these after all are the principal features which must guide any comparisons or examinations. We believe that the book will be found extremely useful to those interested in the subject and possibly to microscopists generally, for starch grains are easily secured, and there is considerable interest attaching to their examination.

"Romance of the Heavens." By Prof. A. W. Bickerton. (London: Swan Sonnenschein & Co. 1901.) 5s. It is an author's [illegible] of a theory which [illegible] opinion. Prof. Bickerton [illegible] persuade [illegible] to accept his theory of [illegible] impact, which is really the subject of this volume. Finding [illegible] "a chaos of facts" he claims to have converted it into a [illegible] system and to have explained the genesis of every type of [illegible]. The leading idea is not difficult of comprehension. Two [illegible] bodies are supposed to come into grazing collision, with the result that the grazing parts are sheared off to form a third body, the mass of which may be so small that the molecular velocities of its particles will cause its dissipation into space; while the two "wounded stars" become variables or possibly form a double star. In its further development, however, when the author pictures collisions of nebulæ, star clusters, meteoric swarms, and cosmical systems, it becomes much more intricate. We must confess that we find the idea of all this collision in an orderly universe quite as repellant as the author appears to find the commonly accepted views as to the degradation of energy and the coming "universal death": how he escapes from the latter can hardly be expressed in a few words. Needless to say, the theory is considered to be absolutely demonstrated by the known facts of astronomy, but much of the evidence brought forward is far too slender to be convincing. It is by no means certain, for instance, that the author's interpretation of the spectrum of Nova Aurigæ is justifiable, and the statement that the masses of the two supposed colliding bodies in that case were respectively eight thousand and four thousand times the mass of the sun only makes us doubt other numerical results. In spite of frequent repetitions and its somewhat florid style, those interested in speculative exercises will find the book readable enough, though, unlike the author, they may not regard "probably" and "possibly" as evidence amounting to demonstration.

BOOKS RECEIVED.

The Complete Works of John Keats. Vol. V. Edited by H. Buxton Forman. (Glasgow: Gowans & Gray.) 1s. net.

The Use of Words in Reasoning. By Alfred Sidgwick. (A. and C. Black.) 7s. 6d. net.

The Mediterranean Race. (Contemporary Science Series.) By G. Sergi. (Walter Scott.) Illustrated. 6s.

A Handbook of Photography. By Mrs. M[illegible] Ma[illegible]. (Dawbarn & Ward.) Illustrated. 1s. 6d. net.

Papers on Mechanical and Physical Subjects. By Osborne Reynolds, F.R.S., M.I.C.E., LL.D. Vol. II. 1881-1900. (Clay.) Illustrated. 21s. net.

Select Bibliography of Chemistry, 1492-1897. By Henry Carrington Bolton. Section VIII.—Academic Dissertations. (Smithsonian Institution.)

Ferguson's Surveying Circle and Percentage Tables. By J. C. Ferguson, M.I.C.E.

The Commonwealth of Cells. By H. G. F. Spurrell, B.A. Oxon. (Baillière.) Illustrated. 2s. 6d. net.

Britain [illegible] the Sea. Compiled [illegible] E[illegible]. (Murray.) 2s. 6d.

Handbook of Rocks, Minerals and Ores. By W. J. P. B[illegible]. (Ha[illegible].) 1s.

Notes on Minerals. By G. C. Broadhead. [illegible].

The North-West Passage by Land. By Viscount Milton, M.P., F.R.G.S., F.G.S., and W. B. Cheadle, M.A., M.D., [illegible] F.R.G.S. (Cassell.) Illustrated. 2s.

The Geological History of the Rivers of East Yorkshire. By F. R. Cowper Reed, M.A., F.G.S. (Clay.) 4s. net.

On the Earthworms collected during the "Skeat Expedition" to the Malay Peninsula, 1899-1900. By Frank E. Beddard, M.A., F.R.S. (From the *Proceedings* of the Zoological Society of London.)

Novæ or Temporary Stars. By J. H. Brown, F.R.A.S. (Brighton: Southern Publishing Co., Ld.)

Morphology of Spermatophytes. By John M. Coulter, PH.D., and Charles J. Chamberlain, PH.D. (New York: D. Appleton & Co.) Illustrated. 7s. 6d.

Biographical, Critical and Miscellaneous Essays and Poetical Works. By Lord Macaulay. (Ward, Lock.) Illustrated. 2s.

All Change. By Wilfred Woollam. (Elliot Stock.) 1s.

Publications of the Smithsonian Institution, March, 1901.

Modern Cremation: Its History and Practice. By Sir H. Thompson, BART., F.R.C.S., M.B. LOND. (Smith, Elder.) 2s.

Cerebral Science. By Wallace Wood, M.D. (Baillière.) 3s. 6d. net.

Grasses. (Cambridge Natural Science Manuals.) By H. Marshall Ward, SC.D., F.R.S. (Clay.) 6s.

The Microscopy of the more commonly occurring Starches. By Hugh Galt, M.B., etc. (Baillière.) Illustrated. 3s. 6d. net.

The Law of Universal Balance. By A Shetlander. (Lerwick: T. and J. Manson.)

The Rustle of His Robe. By Margaret Inez Katharine Kern. (New York: F. Tennyson Neely Co.) 5s. 4d.

The Principles of Human Knowledge. By Geo. Berkeley. (Chicago: The Open Court Publishing Co.) 1s. 6d.

Our Country's Shells. (Simpkin, Marshall.) Illustrated. 6s.

Story of Wild Flowers. By G. Henslow. (Newnes.) Illustrated. 1s.

Animal Life. By Jordan and Kellogg. (Henry Kimpton.) Illustrated. 7s. 6d. net.

Plant Studies. By John M. Coulter, A.M., PH.D. (Henry Kimpton.) Illustrated. 7s. 6d. net.

Star Atlas. By Dr. Hermann J. Klein. (S.P.C.K.) Illustrated. 10s.

Astronomischer Jahresbericht. By Walter F. Wislicenus. (Druck und Verlag von Georg Reimer.)

Debrett's Coming Events: Monthly Calendar of Social Fixtures, etc. (Dean & Son.) 6d. net.

Homoculture by Selection. By Henry Smith, M.D. (JENA). (Watts & Co.) 6d.

Catalogue of Apparatus, Material and Appliances, etc. (Sanger, Shepherd & Co.)

Flies and the Science of Scavenging. By G. V. Poore, M.D. (Reprint from *Lancet*.)

Catalogue Photographic Apparatus. (Sanders and Crowhurst.)

Menagerie of Fauna—Gizeh Zoological Gardens. Report for the Year 1900. By Stanley S. Flower, F.Z.S.

Publications of the Smithsonian Institution—Annual Reports, 1897, 1899 (Two Vols.), and 1900.

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

Starling or Nuthatch? Much has been said lately in praise of the Starling. To the agriculturist the Starling is without doubt a benefactor, owing to the enormous number of grubs it consumes, and its increase in this country within the last few years should prove a blessing to the farmer. By the ornithologist, however, this great increase can hardly be regarded favourably, notwithstanding the interest attaching to the fact itself. The Starling is an amusing bird, but you can have too much of a good thing, and if the Starling continues in his aggressive eater he will soon drive away other more interesting and attractive birds which stand, I venture to say, nearer to our affections than he does. In the New Forest, for instance, the Starling has increased enormously during the last few years. Everywhere about the woods you will find him and his young screech from all the "likely" holes in the trees. The truth is that, with all his clumsiness, the Starling has a keen eye for a good home, and he calmly appropriates, or fights for if necessary, the best nesting holes. The result is that the Nuthatches and the Great Tits, the former especially, have some difficulty in finding nesting sites. One would think there was a limitless supply of nesting holes where there are so many old trees, but every one who has examined such holes knows that a good many conditions have to be fulfilled before a really dry comfortable place for a nest is formed. In the New Forest the Nuthatches have certainly decreased greatly during the period in which the Starlings have been increasing. Personally I would far rather watch and hear one Nuthatch than a hundred Starlings, but what can be done? HARRY F. WITHERBY.

Glossy Ibis in County Durham. (*The Naturalist*, May, 1901, p. 149.) Mr. T. H. Nelson records that a Glossy Ibis, an accidental visitor to Great Britain, was shot near Stockton-on-Tees on November 25th last.

An Observational Diary of the Habits—mostly domestic—of the Great-crested Grebe (Podicipes cristatus). By Edmund Selous. (*Zoologist*, May, 1901, pp. 161-183.) Mr. Selous has already contributed to the pages of our contemporary two papers, to which we drew attention, referring to the Nightjar and the Stone Curlew, similar to the present one. This article, however, is more literary in style, and is therefore more interesting reading, without any deterioration in scientific value, than the previous contributions, which were somewhat wearisome by reason of their excess of detail. Mr. Selous has made a number of interesting observations, regarding especially the nesting and pairing habits of the Grebes. He comes to the conclusions that the birds pair on the nest itself; that the male, in addition to helping the female in building, constructs a platform of weeds at some distance from the nest whereon to rest; and that the birds usually attack their enemies from under the water. Mr. Selous' theories are less happy than his records of facts.

All contributions to the column, either in the way of notes or photographs, should be forwarded to **HARRY F. WITHERBY,** ***at 10, St. Germans' Place, Blackheath, Kent.***

THE INSECTS OF THE SEA. IV.

By GEO. H. CARPENTER, B.SC.(LOND.), *Assistant in the Museum of Science and Art, Dublin.*

BEETLES (*continued from page 116*).

ANOTHER well-marked marine genus of Rove-beetles is Diglossa or Diglotta in which the feelers are relatively long, and the palps of the first maxillæ most remarkably so, while those of the second maxillæ are represented only by long bristles. Two species—*D. mersa*, Haliday (Fig. 7), and *D. sinuaticollis*, Rey—inhabit the British, Irish, French, and Dutch coasts. Elsewhere, Diglotta seems only known on the island of Celebes. In these beetles the wings are reduced, often to very small vestiges. Consequently they do not fly but run actively about in the sunshine over rocks and shingle. *D. sinuaticollis* is said to escape submersion by burrowing in the sand just above high-water mark in company with the Bledii before mentioned. The beetles make little holes about [illegible] and [illegible] therein singly or in pairs. The larva de[illegible] by Haliday has a very large head and [illegible] remarkable in possessing three [illegible].

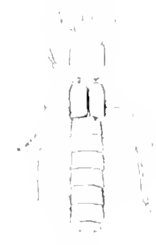
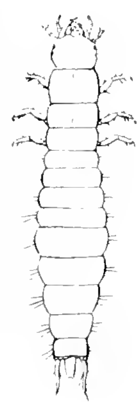


FIG. 6. FIG. 7.

FIG. 6.—Grub of *Diglotta mersa*. (After Haliday.) Magnified 20 times.

FIG. 7.—*Diglotta mersa*. Magnified 20 times.

One other genus of marine Rove-beetles must be mentioned—Micralymma. The European species, *M. brevipenne*, Gyll. (Fig. 8), which occurs on the British coasts, and northwards on the Continent from France to Scandinavia, may be recognised by its comparatively short and broad form. The surface of the body is densely pitted and very finely pubescent. As in Diglotta the wings are much reduced. The insects may be found lurking in crevices of the rocks or walking about on the stones and shingles usually below high-water mark. They are believed to hunt and feed upon the spring-tail *Anurida maritima*, which was referred to in a previous article of this series. A good account of the form, transformation and habits of this little beetle was given more than thirty years ago by Laboulbène.* He found that,



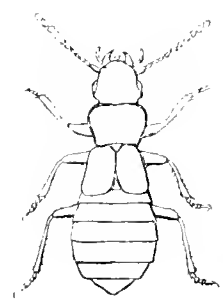


FIG. 9. FIG. 8. FIG. 10.

FIG. 8.—*Micralymma brevipenne*. Magnified 16 times.

FIG. 9.—Grub. (After Laboulbène.) Magnified [illegible] times.

FIG. 10.—Pupa. (After Laboulbène.) Magnified 12 times.

even at low water the insects were reluctant to leave their hiding places, and that they made their way over the rocks rather slowly, hardly lifting the large hind-body from the ground. When taken in the hand they re-

---

A. H. Haliday. "Notes about Cillenum and a sub-marine species of Aleocharidæ." *Ent. Mag.*, IV., 1837, pp. 251-3. Also *Nat. Hist. Rev.*, Vol. II., 1855, pl. 3, and Vol. III., 1857, p. 20. G. C. Champion. "Some Remarks on the two Species of Diglossa occurring in Britain." *Ent. Mo. Mag.*, XXXV., 1899, pp. 264-5. B. Tomlin. "Notes on the Habits of *Diglotta sinuaticollis*," *l.c.*, p. 290.

* A. Laboulbène. "[illegible] Anatomie de la Micralymma brevipenne." *Ann. Soc. Ent. France* (3), VI., 1858, pp. 73-110, pls. I.-III.

warded their captor with "une odeur très mauvaise et très pénétrante."

The grub of Micralymma is more lively than its parent beetle. It is elongate in form, with the legs short, stout, and spiny; the tubular process at the hinder end can be bent downwards to act as a false-foot or pro-leg (Fig. 9). The pupa is a most wonderful creature, with its armature of long bristles that doubtless serve to entangle air-bubbles for breathing (Fig. 10).

As might be expected, the Ground-beetles (Carabidæ)—those active, predaceous, swift-running insects, which lurk commonly under stones and in such places—are well represented by the sea-shore. Space would fail us to enumerate the sand-dwelling Ground-beetles that may be met with above high-water mark. Several kinds of Dyschirius, for instance, small, dark, shining bronzy beetles, with the fore-shins flattened and strengthened to serve for digging, abound on our coasts. They burrow into the sand in pursuit of the Rove-beetles of the genus Bledius mentioned above and ruthlessly devour them.

There is a large group of small Ground-beetles—the Bembidiina—which frequent damp places, and are indeed semi-aquatic in their habits. The most characteristic structural feature of this group, the very short and pointed terminal segment of the second maxillary (labial) palp (Fig. 11, L. p.), is found also in the Haliplidæ, that family of true water-beetles which is most nearly allied to the Carabidæ. The very numerous species of Bembidium are the delight of the specialist, and the despair of the average beetle-collector. Several of them may be found on the sea-shore, but they seem to keep out of the reach of the tides. There is an allied genus, however, Lymnæum—a species of which, *L. nigropiceum*, Marsh, occurs locally on the south coast of England and in the Isle of Wight, lurking under stones and shingle, below as well as above high-water mark. This little beetle inhabits also the French coast and the shores of Dalmatia and the Crimea. The most remarkable discontinuous range of this species is analogous to that of its genus which occurs in Europe, the East Indies, California, and the Kurile Islands near Japan.

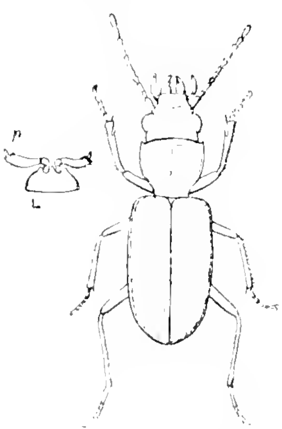


Fig. 11.—*Cillenus lateralis*. Magnified 10 times. L, second maxillæ (labium), magnified 20 times. (*p*, palp.)

Still more specialized for a marine life is *Cillenus lateralis*, Sam. (Fig. 11), the only species of its genus, distinguished from Bembidium by its relatively shorter feelers and parallel-sided elytra, which are of a pale, sandy colour with dark markings, the large head and fore-body being shining bronzy green. Cillenus occurs at many points on the British and Irish coasts, sometimes beneath stones, sometimes on the sand, but almost always below high-water mark. Its continental range extends northwards only to Holland, but southwards as far as Portugal and Morocco. It is remarkable that while British specimens of this beetle are all wingless, those from southern Europe are occasionally winged; evidently the species as a whole has not entirely lost the power of flight. At low water numbers of Cillenus may be found running in the sunshine; when the tide rises they retire under stones, or dig holes between one or two inches deep in the sand. In such shelters they survive in safety their immersion twice every day. A. H. Haliday, in the paper to which reference has already been made, gives a vivid account of the habits of Cillenus as observed by him on the Co. Dublin coast in the year of Queen Victoria's accession. "They prey upon sandhoppers (Talitrus), seizing them by the soft part of the underside, and, in this way, are able to master game many times their own bulk. Sometimes three or four beetles may be found in concert, attacking a sandhopper of the largest size. The tide retiring has scarcely uncovered the sand when these little depredators are abroad from their hiding-places and alert in the chase." The grub of Cillenus has been described by Fairmaire. It has short legs and a very large head with long, formidably toothed mandibles.

Another group of Ground-beetles with marine representatives are the Trechina—a tribe allied to the Bembidiina, but distinguished by the elongate terminal segment of the labial palp (Fig. 13, L. p.). The species of the large genus Trechus live mostly in dark concealed situations, under stones, for example, or in burrows along the banks of streams. One of them, *T. lapidosus*, Dawson, occurs just above high-water mark on the sea-coast and along the shores of tidal rivers. But the small beetles of the allied genus Aepus are perhaps the most characteristically marine members of the whole family, and, indeed, of the entire order of beetles.

Small as these beetles are, 2 mm. (about $\frac{1}{12}$ inch) in length, their aspect when seen with a moderate magnification is striking and not easily forgotten (Fig. 13). The relatively immense head, larger than the forebody shield, and the truncate abdomen, broadest at its hinder end and only partly covered by the wing-cases, give the insect a most characteristic appearance. Both the European species of Aepus occur on the British and Irish coasts. *A. marinus* (Stroem.) has a deep dorsal furrow on the forebody, and rather long parallel-sided wing-cases, while *A. Robinii*, Laboulb., has an indistinct dorsal furrow and shorter wing-cases widened behind. These insects both occur on the French and Spanish coasts, and there is a third species on Madeira, and another far away in Chile. They have not been found north of Denmark, and it is remarkable that they seem to be absent from the newest part of our own coast line—from Yorkshire to Sussex, the region by which our island was in Pleistocene times joined to the European continent. While the range of most of the shore-haunting spring-tails points to an old continental coast-line stretching from our area towards the north, that of Aepus, and, as we have seen, of most of the marine beetles, indicates the former extension of the old land to the south and south-west. Aepus is clearly a very ancient genus, and it is possible that these beetles were amongst the first members of our present fauna to reach our area, belonging as they clearly do, to the south-western (Lusitanian) group, whose restricted distribution shows them to be the oldest animals surviving in our islands.

Several points in the structure of Aepus deserve a passing mention. Wings seem to be quite absent. The widened fore shin, as in several other ground-beetles (in-

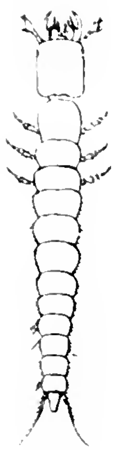


FIG. 12

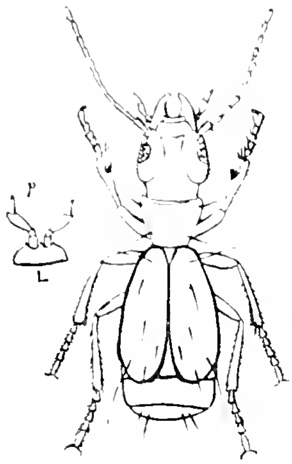


FIG. 13.

FIG. 12.—Grub of *Aepus marinus*. (After Westwood.) Magnified 20 times.

FIG. 13.—*Aepus Robini*. Magnified 20 times. L, second maxilla (labium), magnified 40 times. (*p*, palp.)

cluding Cillenus), has a deep bristle-fringed notch towards its far end; this serves as a comb for cleaning the feelers, which can be drawn through the notch so that particles of sand are removed by the bristles. The compound eye of Aepus is composed of a relatively small number of circular facets; the eye in marine insects is frequently thus, instead of being built up of an immense number of hexagonal facets. Behind the facets, according to Prof. Miall, is situated a concave plate with a circular opening; "the form of this plate," he writes, "suggests that it may be employed as a kind of pin-hole camera." Another interesting fact discovered by Prof. Miall and Mr. Hammond, is the presence of a pair of large air-sacs at the hinder end of the abdomen in Aepus; these "are no doubt useful during prolonged submersion." These beetles are provided with long bristly hairs, which, as Audouin** noticed nearly seventy years ago, serve to entangle air-bubbles when the insect is submerged. "If," he wrote, "one transfers the insect directly from the air into sea-water, one notices that each of its hairs holds a little layer of the surface film, which forming at first tiny spheroids soon unite into a little globule which surrounds its body on every side, and which, despite the agitation resulting from the insect running under the water . . . never escapes. Our insect always carries about a little layer of air, and when it hides beneath a stone, it finds itself at once in the condition of insects living freely in the atmosphere. Coquerel†† made some experiments as to the length of time which Aepus can remain under water. Their habit when the tide rises is to take shelter beneath stones and remain there till the ebb again sets them free. Coquerel found that when immersed under artificial conditions for a very long time "they always finally fell into a state of apparent death. I have kept them [illegible] water for eighteen hours under water. I bel[illegible] dead but having placed them in the sun on a [illegible] paper they revived after some minutes and be[illegible] about as before."

Like its parent beetle, the [illegible] of Aepus has a very large head, armed with sharp, strong mandibles, and is very active in its habits when the tide is out. The hairy covering wherewith it is provided helps to entangle air bubbles. Both beetles and grubs are believed to prey on small molluscs, such as Rissoa, in whose company they are often found.

There is something fascinating in the study of the life of these small beetles, spending, as they must, the greater part of their time under stones on the sea bottom, waiting for the fall of the tide to allow them a few hours' activity in the air, which is, after all, their true element. The observer on the shore, as he watches the breakers rolling in at the flood, may well give a thought to the tiny insects, safe in their hiding-places far beneath the restless waves, waiting there patiently until the ebb shall release them once again from their watery prison.

** J. V. Audouin. "Observations sur un Insecte Coléoptère qui passe une grande partie de sa vie sous la Mer." *Nouv. Ann. Mus. Hist. Nat.*, III., 1833, pp. 117–127.

†† C. Coquerel. "Note pour servir à l'Histoire de l'Aepus Robini et description de sa Larve." *Ann. Soc. Ent. France* (2) VIII., 1850, pp. 529–532.

STANDARD SILVER: ITS HISTORY, PROPERTIES AND USES. III.

By ERNEST A. SMITH, ASSOC.R.S.M., F.C.S.

IT is well known that silver wares, when exposed to ordinary atmospheric influences, soon become disfigured by blotches of tarnish, due to the action of the sulphur in the air, and in consequence require to be repeatedly cleaned to present a bright appearance.

This being one of the drawbacks to silver goods a few remarks on this subject are not without interest, as the surface will become perfectly black in a few months' time if continual cleaning is neglected.

Some interesting directions for the care and cleaning of silver-gilt plate are preserved with the church-plate of Stinsford, in Dorsetshire.* The directions, which are dated June, 1737, are given by Paul Lamerie, the silversmith who made the plate. They run as follows:—

"Clean it now and then with only warm water and soap, with a Spunge, and then wash it with clean water, and dry it very well with a soft Linnen Cloth, and keep it in a dry place, for the damp will spoyle it."

The instructions given by the silversmith who made the plate for Carlisle Cathedral in 1679 may be compared with the above extract as they are equally worth attention. "Be carefull," he says, "to wipe it with a clean soft linnen cloath, and if there chance be any staines or spotts that will not easily come off with a little water, the cloath being dipp'd therein, and so rubb the flagons and chalices from the topp to the Bottome, not cross wise, but the Bason and patens are to be rubb'd roundwise, not acrosse, and by noe means use either chalke, sand, or salt." These last words cannot be too strongly emphasised, as much damage is frequently done to silver plate by excessive rubbing and the use of injurious cleaning materials. The simple directions given by Paul Lamerie and his brother silversmith still serve as a good guide for cleaning plate. By the adoption of the following process it is stated† that large stocks of silver [illegible] may be protected against atmospheric influence [illegible] will remain as bright as when first new.

* Quoted by Cripps, "Old En[illegible]," 6th Edit. 1899, p. 15.

† "Jeweller and Metalwork[illegible] XXXI. (1900), p. 102.

The process consists in coating the wares with a thin solution of collodion varnish, diluted with spirits of wine to a thin fluid. The articles should be slightly warmed, and the varnish applied by means of a soft white bristle brush, and on the evaporation of the spirit a thin transparent film of glossy substance is left behind, which preserves the brightness of the metal, and dispenses with the constant labour otherwise required in keeping the articles fresh and lustrous. As a thorough safeguard against tarnishing it is advisable to paint the articles more than once. The varnish is easily removed by means of warm water.

Articles which have become very much tarnished may be restored by carefully rubbing them over with a clean piece of soft cloth wetted with a dilute solution of potassium cyanide (about 1 oz. to 1 quart of water), and then well rinsing them in clean water when the silver appearance has returned.

Owing to the want of sufficient data it is somewhat difficult to ascertain the total quantity of standard silver prepared annually in the United Kingdom, but an approximation to this quantity may be obtained from data published in the Annual Reports of the Royal Mint.

The following figures, taken from the most recently published Mint report, gives the total quantity of standard silver prepared in the year 1899 for the purposes of coinage and medals, and also the quantity marked at the Assay Offices of Birmingham, Sheffield, and Chester.

Quantity of Standard Silver prepared at the Royal Mint in 1899.

	Ounces.
For Imperial Coinage (925 standard) ...	10,677,155
For Colonial Coinage (925 standard) ...	251,531
For Colonial Coinage (800 standard)	5,743,657
For War Medals (925 standard) ...	52,015
Total ...	16,724,358 or 512 Tons.

Assay Office Returns for 1899 (Mint Report).

	Ounces.
Silver marked at Birmingham ...	2,823,525
Silver marked at Sheffield	1,323,917
Silver marked at Chester ...	741,044
	4,888,486 or 149½ Tons.

No official returns are made of the weight of silver marked annually at the Assay Offices of London, Scotland, and Ireland, but the following figures are given by Redman‡ for 1898.

Quantity of Silver marked at other Assay Offices in 1898. (Redman.)

	Ounces.
London	2,103,652
Edinburgh	15,113
Glasgow	15,321
Dublin ...	8,123
Total	2,142,509

This latter quantity added to that marked at the Assay Offices quoted above gives a total of 7,030,995 ounces (215 tons) of silver used for industrial purposes.

It may be remarked that the weight of foreign silver wares which are imported and marked in this country is included in this total, but the amount is comparatively small.

After making allowance for the quantity of standard silver used annually for the manufacture of small articles which are exempt from Hall marking, a total of twenty-two and a half million ounces or about 689 tons would probably be a fair approximation to the total quantity of standard silver prepared annually in the United Kingdom.

By an Act of Parliament passed in 1867 (30 and 31 Victoria, c. 90, s. 1), annual licences must be taken out by every dealer in silver articles in respect of any shop, and by every hawker or pedlar, a penalty of £50 being imposed for dealing without licence. For silver wares above 5 dwts. and under 30 ozs. in one article the licence is £2 6s. 0d., above 30 ozs. £5 15s. 0d.

In order to prevent the manufacture of spurious plate, the law requires that the quality of the metal of all silver wares, with certain exceptions, shall be determined by assay at offices duly authorised for that purpose in various parts of the Kingdom, and that if it be found equal to standard it shall be stamped at those offices with a series of marks, but that if the wares are found to be below standard they shall be broken up and the silver returned to the owner, who is to be charged a penalty of 6d. per ounce.

The marks employed denote the quality of the standard, the place of assay, and the year; the law also requires that all wares sent to be assayed must bear the maker's mark. The name of the maker is indicated by his initials; the standard of 11 ozs. 2 dwts. (925) by a lion passant; and that of 11 ozs. 10 dwts. (959) by a lion's head erased (*i.e.*, without the body) and the figure of Britannia, except at Birmingham and Sheffield, where Britannia alone is used; the place of assay is indicated by heraldic arms, and the year of assay by a letter, which is used throughout the year and is changed every year.

Duty was formerly charged on all silver wares, the payment of duty being indicated by the sovereign's head, but this has been omitted since 1890 when the duty was abolished.

At the present time there are four Assay Offices in England, for which the arms are as follows:—

Birmingham	An anchor.
Chester	A sword between three garbs.
London ...	A leopard's head (the arm of the Goldsmiths' Company).
Sheffield	A crown.

Formerly there were nine Assay Offices, but those at York, Exeter, Bristol, Norwich, and Newcastle-on-Tyne have been closed, probably on account of the trade being transferred to other centres such as Birmingham, Coventry, Sheffield, and London.

There are two Assay Offices in Scotland, one in Edinburgh, and one in Glasgow, where a series of marks corresponding to the English is used, but the standard 925 is indicated by the thistle, with the addition of Britannia in the case of the standard of 11 ozs. 10 dwts.

The arms of the Scotch Assay Offices are:—

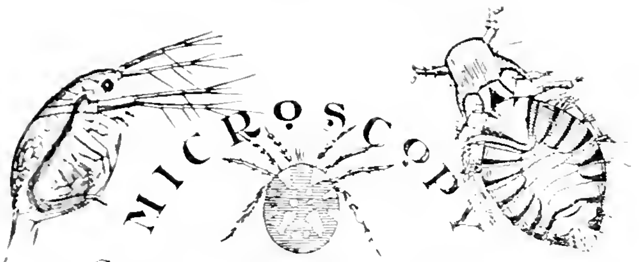
Edinburgh ...	A castle with three towers.
Glasgow ...	A tree growing out of a mount, with a fish and bell.

The office at Glasgow has not adopted the marks prescribed by the above statute, but uses the lion rampant instead of the thistle to denote the standard.

In Ireland the assaying and marking of silver plate is restricted to Dublin, where a series of marks corresponding to the English is also used. The place of assay is indicated by a figure of Hibernia, and the standard, which is 11 ozs. 2 dwts., by a harp crowned. No silver wares of the "new standard," 11 ozs. 10 dwts., are marked in Ireland.

‡ "Hall Marks," Redman, 1900 Edit. p. 131.

There are no doubt some objections, as Chaffers remarks,§ to the principle of compulsory assaying and marking of gold and silver wares. In this country, however, the system has existed substantially in its present form since the reign of Edward I. Without speculating on its origin, and while making due allowances for its defects, it is established that it has resulted in the creation and maintenance of a high standard of excellence for all British assayed wares, which has not only raised the reputation of British workmanship at home and abroad, but has also created a large amount of private wealth readily convertible into money by reason of the guarantee of value which the Hall-marks afford.



Conducted by M. I. Cross.

REICHERT'S FINE ADJUSTMENT (*continued*).—Since the appearance of the June number, Reichert has written stating that for each turn of the milled head controlling his new lever form of fine adjustment, a movement of ·01 m m is produced; in his ordinary system of direct-acting screw, the rate of movement per revolution of the milled head is ·3 m m.

It will be seen that the rate of movement is three times as slow with the new fine adjustment. The new arrangement also permits of the use of coarse screws, which are obviously not so liable to wear as fine ones, and the whole of the mechanism is of steel. The entire construction is undoubtedly thoroughly sound mechanically, yet very simple in design, and exceedingly efficient practically. It is a distinct improvement to the Continental stand.

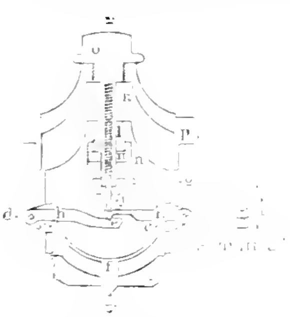


Fig. 1.—Sectional View, [illegible] lever arms [illegible] point [illegible] contact with levers controlled by screw [illegible] b, point which communicates the movement from levers through [illegible] tube [illegible].

Fig. 2.—External appearance, [illegible] fulcrum of lever arms.

ZEISS'S FINE ADJUSTMENT.—This is fitted to a new stand for photo-micrography and projection only, and in actual working is exceedingly steady, sensitive, and soft to the touch.

The stand to which it is applied is arranged for use with Zeiss's new Planar lenses, which work without eye-pieces, and are intended for photographing large objects, there being sufficient room on the stage for an object 150 m m in diameter; and, on the other hand, it is designed to work for projection or photography with objectives of the highest aperture and power.

It is extremely gratifying to find that a firm occupying the position that the house of Zeiss does in the optical world should have devised an improvement in so important part as the fine adjustment.

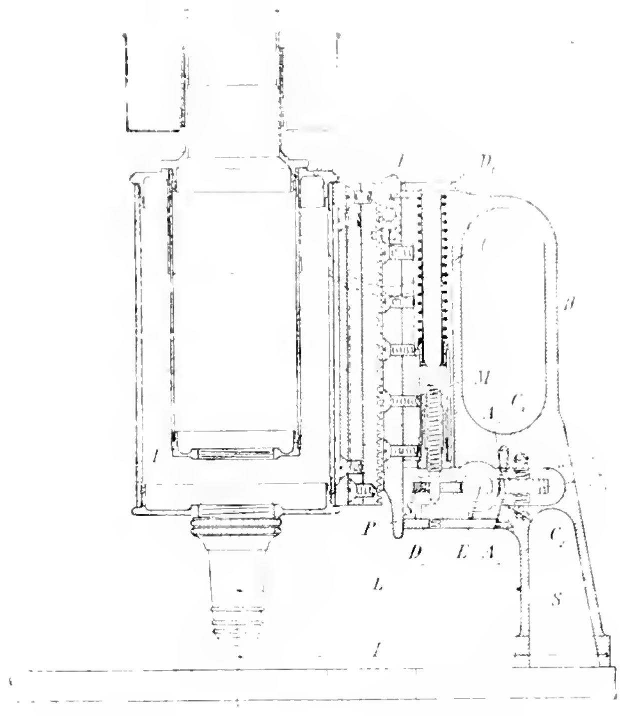


Fig. 3.—Sectional Views of Zeiss's Improved Fine Adjustment.

The slowest fine adjustment they made previously gave for each turn of the milled head ·25 m m; in this new one a movement is produced of ·04 m m for each revolution of the milled head, that is, it is six times as slow as the ordinary pattern. This in itself is an immense advantage.

Fig. 4.—K, Controlling Milled Heads of Fine Adjustment.
(For description see text.)

It will be noted that the two controlling screw heads are parallel, and instead of being placed at the top of the limb, as is usual in Continental models, are set on either side of the limb of the instrument. They are small in diameter, so that when low powers are used they can be revolved rapidly between the fingers.

The drawings are self-explanatory. It will be seen that the movement is affected by a cog-wheel system. The endless screw E operates the cog-wheel S, causing the long screw M to rotate, the reactionary effect being produced by the spiral spring U.

To prevent the over-turning of the screws, a cog, S, is provided, and this travels up and down on the pin G; stops are fitted A and A, which come in contact with C and C when

§ Chaffers, "Hall Marks on Plate," 8th Ed., 1903, p. 4.

the fine adjustment is carried to its limit, and thus undue strain is prevented.

The construction presents features of originality and ingenuity. Every care has been taken to obviate unequal pressure, and consequent deterioration, and the whole mechanism is built in an extremely solid and workmanlike fashion.

STRINGER'S FINE ADJUSTMENT (made by W. Watson & Sons).—This is, to some extent, an amplification of Watson's Standard pattern.

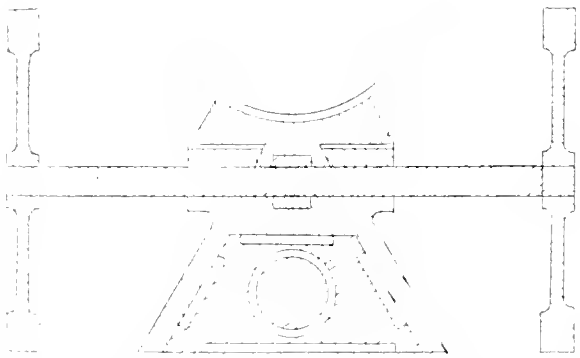


FIG. 5. Stringer's Fine Adjustment, showing sectional view of triangular fitting bar, points of contact, body tube, coarse adjustment milled heads, &c.

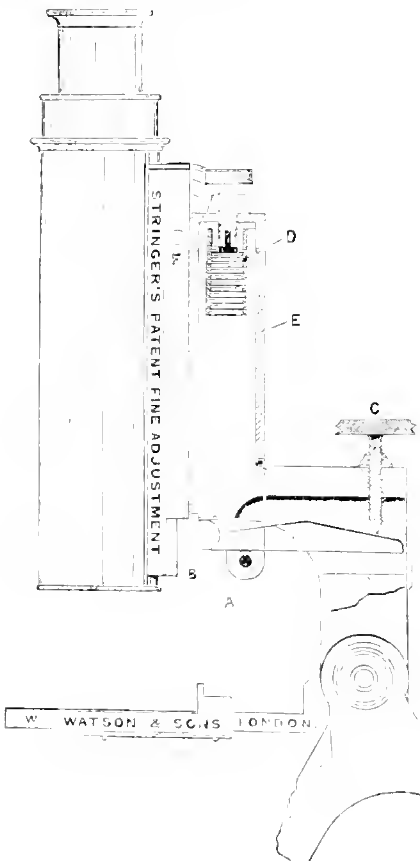


FIG. 6. Sectional View of Stringer's Patent Fine Adjustment.

An examination of the drawings showing the cross section of this fine adjustment will at once reveal that it is made in a very substantial manner. The bar E, which is cast in one piece with the limb, is triangular in shape, and fitting exactly round it is a sleeve in which are grooved the dovetails that receive the body of the microscope.

The movement is effected by a lever of the second order, which operates by pressure upon a steel revolving pin A. This pin is mounted between two arms that are continued downwards, and are part of the sleeve fittings of the fine adjustment, the fulcrum being at B.

It will be seen that, contrary to the usual custom, the body is drawn downwards by the lever, and upwards by the spring D. A screw is provided for regulating the tension of this reactionary spring according to the angle at which the microscope may be inclined. Due provision is made for adjustment for wear, the frictional points of the bar E being very small, as shown in the cross section drawing, and the large back plate having adjustment screws so that the fitting may be altered as required.

The rate of movement of a fine adjustment of this description would necessarily vary with the size of the limb of the microscope, but the average rate of movement per turn of the milled head is ·05 m/m.

The special virtues claimed for this fine adjustment are extraordinary strength of construction, enabling it to stand rough treatment, and extreme sensitiveness. There is every indication that these claims are fully justified.

NOTES AND QUERIES.

J. F. A.—I have heard it stated that the blood of an habitual drunkard is different in appearance microscopically to normal blood. Can you tell me if this is correct, and if so, in what way it differs?

If any reader can obtain a drop of blood from such a subject and spread it on a microscope slip or cover glass, this question could no doubt be settled, but I am not aware of the existence of a difference.

T. H. M.—Of the microscopes you name, the D.P.H. No. 1 by Baker is unquestionably to be preferred. It is well designed and soundly constructed.

S. P.—Light filters are a necessity for photo-micrography of coloured objects. You cannot get satisfactory contrast without them. Of solutions, acetate of copper or Gifford's screen are the best, but opticians sell coloured glasses which usually serve the purpose. If these are used close to the lamp flame, they should be optically worked, any defect in the glass being present in the field of view when the condenser is focussed. If the coloured glass be placed immediately beneath the condenser, the optical working is not a necessity. The latter position is equally as good as the former.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

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

COMET A 1901.—A considerable number of observations of this object have been published in the *Astronomische Nachrichten* and other journals. The proximity of the comet to the sun must have rendered it difficult to determine positions accurately, but there is little doubt that the orbit will be satisfactorily obtained. The comet was observed at various stations in South Africa and Australia, it was also seen at Trinidad and at Mount Hamilton, California. But the conditions of its appearance were such that it came under notice at very few northern observatories. In fact, after perihelion its orbit could scarcely have been more unfavourably placed with reference to observers in the northern hemisphere of the earth. The comet approached us from the region west of the sun, and could only have been visible in the morning hours, then moving eastwards and curving round the sun at a distance of about 15 degrees south of that luminary, it went off almost in a direct line into space just before it had got sufficiently far east of the sun to be well observed in the evening sky. But for the brilliancy of the comet and the conspicuous character of its tail it would no doubt have entirely escaped observation. That pretty large objects of this kind occasionally pass unseen is perfectly certain, for a bright comet was situated close to the sun during a total eclipse on May 17, 1882, and only one view was obtained of it. The recent comet [illegible] during [illegible], and the hope was [illegible] evening sky during May [illegible] disappointed [illegible] trying to catch a glimpse [illegible] to know that naked-eye comets [illegible] visible nearly every year and that they will probably not have long to wait before viewing one of these wonderful and mysterious visitors.

DISTRIBUTION OF COMETARY PERIHELIA.—With regard to the comets of short period, belonging to the Jovian family, of which there are now about 32 known with more or less certainty and probably quite distinct bodies (though less than half of them have been observed at more than one return), it is remarkable that the longitude of perihelion falls between 300°–360° and 0°–60° in 20 cases, whereas it is found between 60°–300° in only 12 cases. In other words, while 120° of longitude claim 20 comets, 240° claim only 12. Were the distribution perfectly equable the proportionate numbers instead of being 20 to 12 would be 10·7 to 21·3. The dense grouping therefore between 300°–360° and 0°–60° is significant that some special cause has operated in arranging these cometary perihelia on one and the same side of the sun. In this connection it is also interesting to note that the number of meteors encountered by the earth in passing from longitude 270°–360° and 0°–90° is about double that met with in moving from 90°–270° and a partial explanation may be found in the special accumulation of cometary paths on that side of the sun near the first point of Aries where the earth would be likely to pick up more fragments than on the opposite side in a region traversed by comparatively few comets. This grouping does not, however, appear to be true of parabolic comets, according to some deductions by Chambers in his *Descriptive Astronomy*, but the subject is of sufficient importance to be investigated on the basis of all the materials obtained up to the present time. Though only 32 Jovian comets (including the certain and doubtful instances) are known, it is likely that any peculiarity affecting the distribution of these also affects the whole class, which probably numbers some hundreds at least, for in spite of the perseverance and success of comet seekers during the past century, it is certain that a great many short period comets have managed to evade discovery.

LARGE METEORS.—In the spring and early summer seasons there is little to offer special attractions to meteoric observers apart from the April Lyrids and May Aquarids. But there are a considerable number of minor showers visible in various parts of the firmament, and brilliant fireballs are occasionally recorded. A few bright meteors were observed in May, 1901, and the following are some particulars:—

May 11, 14h. 2m. Equal to Sirius. Passed from one-third the distance from ξ to ζ Draconis to η Cephei. Prof. A. S. Herschel, Slough.

May 11, 14h. 27½m. Equal to Vega. Path, 270° – 10° to 285° – 10°. Duration 3 seconds. W. H. Mordoch, Glasgow.

May 14, 11h. 3m. Equal to Vega. Path, 125 + 30 to 148 + 12. Duration 7 seconds. Prof. Herschel, Slough.

May 15, 9h. 3m. Very large, and estimated ten times more brilliant than Venus. Fell from altitude 60° due N. to 30° N.W. D. R. Springall, Norwich.

May 15, 10h. 0m. Brilliant meteor of a green hue, and leaving a tail of red sparks, passed vertically down S. by W. sky, near horizon. Miss L. M. Milner, Torquay.

May 16, between 11h. and 11h. 15m. Large meteor about twice the size of Mars passed from near α Herculis through northern part of Cepheus and disappeared just under the Polar Star. It moved very slowly. W. H. Venables, Tripoli, Barbary.

May 17, 12h. 25m. Brighter than Jupiter. Travelled from the head of Serpens to N.W., ending between α and η Boötis. Dr. F. Noble, Radfield-by-Sittingbourne.

JULY METEORS.—With July we have the advent of the most interesting part of the meteoric season. After the middle of the month shooting stars become numerous, and towards the end there are many Aquarids and Perseids. This year observations will be best made in the comparative absence of moonlight between the 10th and 27th, though even at the close of the month and early in August there will be plenty of meteors to record in spite of the presence of our satellite. It will be important to watch for the earliest manifestation of the Perseids at about the middle of July, and to determine the position of the radiant on any and every night when a sufficient number of paths have been registered to indicate it satisfactorily.

THE FACE OF THE SKY FOR JULY.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 3.48, and sets at 8.18; on the 31st he rises at 4.23, and sets at 7.49. He is at his greatest distance from the earth on the 4th at 5 P.M., his apparent diameter then reaching its minimum value of 31′ 30″. The appearance of a large spot during the latter half of May suggests that the sun has entered on a new period of spot activity.

THE MOON.—The moon will be full on the 1st at 11.18 P.M., will enter last quarter on the 9th at 3.20 A.M., will be new on the 15th at 10.11 P.M., will enter first quarter on the 23rd at 1.58 P.M., and will be again full on the 31st at 10.34 A.M. The following are among the occultations visible at Greenwich 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 2	B.A.C. 6710	6.0	9.29 P.M.	157	186	9.47	184	212	16 8
„ 3	B.A.C. 7063	6.2	6.59 P.M.	151	182	10.17	181	210	17 9
„ 28	21 Sagittarii	4.9	9.51 P.M.	60	61	11.6	282	271	13 0
„ 29	d Sagittarii	4.9	8.35 P.M.	96	116	9.48	243	252	13 23

THE PLANETS.—Mercury will be an evening star until the 13th, when he will be in inferior conjunction with the sun, and will be a morning star during the remainder of the month.

Venus is an evening star, but sets about an hour after the sun throughout the month. On the 15th the illuminated part of the disc is 0.936.

Mars is now of little interest to the observer, and can only be observed for a short time after sunset. On the 1st he sets about 11.17 P.M., and on the 31st about 9.45 P.M., his apparent diameter dwindling from 6″·2 to 5″·4. The planet moves in an easterly path a little south of the stars β, η, and γ Virginis.

Jupiter is fairly well placed for observation, though the low altitude places the planet at a disadvantage for observers in our latitudes. His path is retrograde, or westerly, in Sagittarius. On the 1st the meridian passage is at 11.58 P.M., and on the 31st at 9.45 P.M., the apparent diameter diminishing from 43″·4 to 42″·2. The following table indicates the more interesting satellite phenomena at convenient hours:—

		H.	M.	S.			H.	M.	S.
1st.	I. Oc. R. ...	9	11	0	20th.—	II. Ec. R. ...	11	43	24
3rd.—	III. Tr. I.	11	2	0	23rd.—	I. Tr. I. ...	9	13	0
	III. Sh. I.	11	22	0		IV. Oc. R.	9	11	0
4th.	II. Tr. I. ...	9	22	0		I. Sh. I. ...	10	17	0
	II. Sh. I.	9	35	0		I. Tr. E. ...	12	4	0
	II. Tr. E.	12	10	0		I. Sh. E.	12	34	0
	II. Sh. E. ...	12	23	0		IV. Ec. D. ...	12	37	52
7th.	I. Tr. I.	11	18	0	24th.	I. Ec. R. ...	9	52	16
	I. Sh. I.	11	59	0	27th.	II. Oc. D.	10	15	0
8th.	I. Oc. D. ...	9	7	0	28th.	III. Oc. D.	10	52	0
	I. Ec. R.	11	34	24	29th.	II. Tr. E. ...	8	6	0
11th.	II. Tr. I.	11	37	0		II. Sh. E. ...	9	29	0
	II. Sh. I. ...	12	10	0	30th.	I. Tr. I.	11	29	0
15th.	I. Oc. D. ...	10	51	0		I. Sh. I.	12	11	0
16th.	I. Sh. I. ...	8	22	0	31st.	I. Oc. D.	8	48	0
	I. Tr. E. ...	10	15	0		I. Ec. R. ...	11	47	0
	I. Sh. E. ...	10	39	0					

Saturn, a little to the east of Jupiter, is in opposition on the 5th, being on the meridian at 12.20 A.M. on the 1st, and at 10.14 P.M. on the 31st. On the 24th, the apparent polar diameter of the planet is 17″·4, and the major and minor axes of the outer ring 42″·4 and 18″·1 respectively, the northern side being turned towards the earth.

Uranus is fairly well placed for observation, nearly midway between η Ophiuchi and Antares, crossing the meridian at 10.13 P.M. on the 1st and at 8.12 P.M. on the 31st.

Neptune is too near the sun for observation.

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.

Observers desirous of following the variations of Nova Persei will find an excellent guide to its position in the photographs by Mr. Stanley Williams, which appear elsewhere in the present number.

There will be a minimum of Algol at 10.34 on the 17th.

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.

(Mrs. W. J. Baird.)

1. B to B6, and mates next move.

No. 2.

(D. L. Anderson.)

Key-move.—1. P × B, becoming a Bishop.

If 1. . . P to R8 (becoming a Knight), 2. B to R3, etc.
1. . . P Queens, 2. Kt to K7, etc.

[This problem has been kept in reserve for some months with the intention of letting it act as a "separator" at the end of the first half of the tourney. It has fulfilled its function admirably, the result being considerable gaps in the score. Apart from the "trickiness" of the actual key, the problem is noteworthy on account of the beautiful "try" by 1. P to B7, met only by B to Q3, and if then 2. BP queens, B to B2. 1. P × B, becoming a Queen, is answered by P to R8, becoming a Knight, and stalemate will result.]

J. E. Whitehouse.—In No. 1. B × R is answered by B to R3, or P to B5.

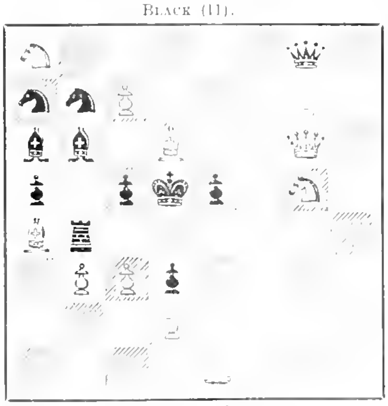
H. Le Jeune and *Alpha.*—You will see that your corrections as to No. 2 have been noted.

PROBLEMS.

No. 1.

By A. H. Williams.

Black (11).



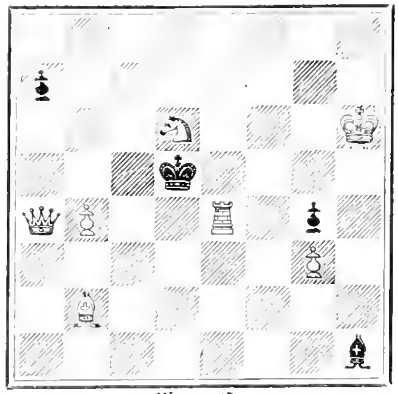
White (11).

White mates in two moves.

No. 2.

By B. G. Laws.

Black (4).



White (7).

White mates in three moves.

The following is the present score in the Solution Tourney:—

Thirty-two points.—S. G. Luckcock, C. Johnston, J. T. Blakemore, A. C. Challenger, W. Jay.

Thirty-one points.—J. Baddeley, G. Groom, W. H. S. M., F. Dennis, G. W. Middleton, H. Le Jeune.

Twenty-nine points. G. W., Alpha.

Twenty-eight points.—V. H. Macmeikan, F. J. Lea, W. de P. Crousaz, C. C. Massey, Eugene Henry, A. J. Head, W. Nash, J. Sowden, E. Hunt, J. E. Broadbent, C. Child.

Twenty-six-points.—G. A. Forde (Capt.), A. H. Machell Cox, H. Boyes, C. E. P.

Twenty-five-points. Endirby, C. C. Pennington.

CHESS INTELLIGENCE.

A match between Scotland and the North of England, with 25 players aside, resulted on May 25th in a decisive victory for the Scottish team, the score being 13 to 6, with six games left over for adjudication. The match was played at Glasgow, so that the winning side were naturally well represented, the losers being considerably handicapped by the railway journey and the absence of Mr. Burn and many other of their leading players. A return match will probably take place at Manchester next May.

Essex have created a surprise by defeating Surrey in the Southern Counties' Competition. The score was 8½ to 7½, the winning team being led by Mr. W. Ward and Dr. Smith, who defeated Mr. G. E. Wainwright and Mr. A. Curnock.

The Hastings Chess Club, certainly one of the strongest organizations in the South of England, has arranged a chess tour for next month. They will play matches with Wiltshire, Bath, Bristol, Cheltenham, South Wales, Cork, and the two leading Dublin clubs.

KNOWLEDGE

AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

VOL. XXIV.] LONDON: AUGUST, 1901. [No. 190.

CONTENTS.

FLOWERING PLANTS,

AS ILLUSTRATED BY BRITISH WILD-FLOWERS.

By R. LLOYD PRAEGER, B.A.

IV.—FLOWERS AND FRUITS.

SOME of the leading characteristics of those all-important parts of plants which we call flowers were touched on in my last article, and the uses and more striking variations in shape and colour of the individual blossom were briefly dealt with. From the individual flower we may pass on to the consideration of inflorescences, or groups of flowers considered as a whole. Most of the wind-fertilized plants have their flowers arranged in more or less elaborate inflorescences—the beautiful compound panicles of many grasses furnish examples, and the dense flower-spikes of the Reed-mace and the sedges. In these cases, as already pointed out, the most advantageous position for the flowers to occupy is the apex of the stem, where they will receive the greatest amount of air and light: hence the minute flowers of plants such as the two named are crowded together often in enormous numbers at the top of the upright stems. In insect-fertilized flowers, where conspicuousness is a desideratum, development has proceeded in two directions, and showiness may be due either to the great enlargement and coloration of parts of the individual flower, or to the grouping in a dense inflorescence of numerous smaller flowers; and, of course, all kinds of combinations of these conditions occur. In most of the plants in which the former extreme prevails, the flowers are solitary; the single blossom is sufficiently conspicuous to attract the attention of insects.

In the second photograph in my last article, the contrast between these two methods of "advertising" is clearly shown. Many instructive examples of the grouping of blossoms are to be found among our familiar wild flowers. Our commonest Orchids, such as belong to the genera *Orchis*, *Habenaria*, and *Listera*, have their blossoms arranged in a dense *spike*—a close-ranked pyramidal or cylindrical mass of flowers. But no one blossom covers or obscures another—a fact the more noteworthy when we recollect that each, as it expands, twists itself upside down. In the Teasel, each of the little lilac flowers which form the dense head is subtended by a stiff quill-like bract, which, projecting far beyond the blossom, forms an effective protection against grazing animals, while providing a convenient platform on which insects may alight. In the large order of *Umbelliferæ*, to which the Carrot, Hog-weed, and Parsley belong, a singularly conspicuous flower-mass is produced by means of an elaborate system of branching. The flowering stem divides at one point into a number of short radiating branches, of which the outer are the longer, so that the apices of all lie in a plane or slightly convex surface. If a flower were borne at each apex, a *simple* umbel would result; but in most of our commoner representatives of the order, each branch again divides into a similar series of branchlets, each of which bears a blossom. A large and conspicuous flat circular expanse of flowers is the result. Similar effects are produced in some other familiar plants by a less formal mode of branching: the Elder, for instance, furnishes a case in point. In some of the common *Umbelliferæ* an interesting feature may be noted. If the inflorescence of the well-known Hog-weed be examined, it will be observed that in those flowers of each umbellule or secondary umbel which are outermost, and especially in those which form the margin of the whole umbel, the petals on the outer side are considerably larger than those on the inner side. The petals of the inner flowers, and the inner petals of the outer flowers, could not increase in size without interfering with the neighbouring flowers; but where there is room for expansion, the plant has not lost the opportunity of rendering its blossoms more conspicuous. A similar feature may be noted in plants belonging to other orders—in the Field Scabious, for instance, where the outer flowers of the close head possess much enlarged corollas, which are quite unequal owing to the greater growth of the free side. In certain other familiar plants, this idea has been adopted to a much greater extent. Examine the inflorescence of the common Guelder-Rose, *Viburnum Opulus*. The greater number of the flowers of each large *cyme* have small corollas of a greenish white colour. But the marginal flowers have large white corollas, to produce which the essential parts of the flower—stamens and pistil—have been sacrificed. The flowers consist simply of a great corolla, and their object is to direct the attention of insects, not to themselves, but to the adjoining perfect flowers which are awaiting fertilization. This plant, in fact, keeps an advertising staff, whose sole duty is to draw attention to the wares offered by the comparatively inconspicuous normal flowers. In several species of Knapweed, notably in the handsome *Centaurea Scabiosa*, a similar division of labour is to be found. In other plants the leaves are pressed into the service as advertising agents. A notable example is furnished by the little Dwarf Cornel, *Cornus suecica*, found in mountain pastures. The umbel of small dark purple flowers is set in four conspicuous white petal-like leaves, which serve the purpose of the showy corollas of so many entomophilous flowers. In many of the *Compositæ*, which form so large an order, this differentiation of flowers exists in a marked degree. Of the Knapweeds we have already spoken. In the Daisy and many of its allies, the majority of the flowers are small, with a yellow regular corolla, enclosing male and female organs. The mass of yellow flowers is surrounded by a ring of flowers possessing female organs only, in which the corolla is white, and is prolonged on the free side into a conspicuous limb. In the allied Dandelion group, the corollas of all the flowers are enlarged on one side in this way, and point outwards from the centre. The accompanying photograph illustrates characteristic species of our two largest orders of grouped flowers—the Umbellifers and Composites.

Fig. 1.—Wild Angelica and Ox-eye Daisies. Illustrating the conspicuous effect produced by the grouping of numerous small flowers.

When flowering is over, and by means of insects or the wind or other agencies fertilization has been effected, there follows a period uninteresting to the casual observer, but of the greatest importance to the plant—the period of the growth and development of the fruit—that is, of the seed and its envelopes. In many cases, beyond the falling off or withering of the no longer useful showy parts of the flower, no external change is noticeable; but in many plants this is a period of vigorous growth—as in the Peas and Beans and many Cruciferous plants, and in plants with fleshy fruits, such as the Apple and Plum. The corolla, when its work of advertisement is done, usually falls; sometimes, as in our common Heaths, it remains dry and withered, and no doubt serves to protect the ripening fruit. The outer whorl, or calyx, is more persistent, and very frequently wraps about the young fruit, often growing as it grows, and forming a protective envelope. In many plants interesting movements may be noted between the periods of flowering and fruiting. In the numerous Pondweeds, for instance, which grow submerged or floating in water, the flowers are wind-fertilized, and during the period of blossoming the spikes of flower stand up erect above the water owing to curving of the flower-stem. When flowering is over, a reverse curvature submerges them, and the fruit is ripened below the surface, where it is less liable to misadventure from wind and wave. In the Water-Crowfoots, which are insect-fertilized, the same movement may be observed. A reverse movement is noticeable in various insect-fertilized land flowers. The buds of the Wild Hyacinth, Columbine, St. Dabeoc's Heath, are erect, but on expanding the bell-like flowers hang mouth downward, thus protecting the delicate essential organs from rain and cold. When flowering is over, the erect attitude is resumed, and the fruit ripens in that position. The Meadow Crane's-bill and Wood Crane's-bill are closely allied species, and much resemble each other in general appearance; but while the fruit of the one stands erect, in the other each fruit is pointed downward. What subtle difference between the mode of life or surroundings of the two plants has produced this change of posture since their derivation from a common ancestor, it is not easy to conjecture.

And now, as the result of this long life-history, the seed lies mature and ripe within the seed vessel—be it a leathery pod, or a woody box, or a juicy berry or pome; and the seed vessel is ready to separate from the parent stem, or to open and allow the seeds to escape. This is a critical time in the plant's history; quite as important as the period of flowering. On the successful sowing of the precious seed depends the life of the succeeding generation. What wonder then if we find, in connection with seed-dispersal, arrangements as elaborate and contrivances as ingenious as those which we have glanced at in connection with flower-fertilization.

In comparatively few cases do the seeds merely fall to the ground beside the parent plant, with apparently no means of further dispersal—the Buttercups and Wood Anemone appear to belong to this category. More frequently advantage is taken of some motive agent, which can assist the seed to a wider dissemination, that it may grow up clear of the impending shade of the parent, and of the exhausted soil which surrounds it, and by seeking fresh woods and pastures new, colonize the country and hold its own in the rough-and-tumble of overcrowded vegetation. These motive agencies are furnished by wind and water—notably by the former—and by animals. The simplest cases of wind-dispersal we see in the swaying of the herbs and trees as the breeze rustles through the woods and meadows. In many plants the ripe fruit or seeds lie in cup-shaped or saucer-shaped receptacles, out of which they would not in a con[illegible] fell into the [illegible] of the [illegible] vessel on the stem [illegible] allowed the escape [illegible] contents. The saucer-shaped receptacle [illegible] of the [illegible] furnish a familiar example. Most of the plants of the Pink tribe (*Cary[illegible]*) have dry capsules, which open at the top when the seeds are mature, and of similar structure is the fruit of the Columbine, the Poppies, the Henbane. The fruit of the last named consists of a woody urn-shaped vessel, surrounded by the enlarged calyx, and closed at the top by a beautifully fashioned close-fitting lid, which, when the fruit is ripe, falls off, exposing the seeds within. All these plants have stiff upright stems. A gust of wind or the brushing past of an animal bends the stems, which spring back into their upright position, and in so doing project the seeds out of the seed vessel. Fruits arranged on this plan have aptly been called catapult-fruits. The wind similarly assists dispersal in the case of heavy-fruited trees, such as the Spanish and Horse Chestnuts. It is chiefly during gales that the fruit is torn from the branches, and flung by the swaying boughs clear of the umbrage of the parent. In these cases heavy fruits are a positive advantage, their momentum carrying them to a greater distance than a lighter body would reach. The majority of wind-dispersed plants, however, work towards the opposite extreme, and ensure transport by means of the extreme lightness of the fruits. The Orchids and Broom-rapes, for instance, produce an immense quantity of dust-like seeds; a single seed of the Lady's Tresses, *Goodyera repens*, is estimated to weigh no more than one-five hundred thousandth of a gram. A large number of other seeds or fruits, heavy in comparison with the foregoing, increase their buoyancy by means of wing-like or feathery appendages, which offer resistance to the air, and in consequence tend to fall slowly. Sometimes the seed itself bears a membranous wing. In other cases, as in the Ash, it is the envelope which encloses the seed that is flattened and wing-like. In the Sycamore, the wrapping of each seed is prolonged on one side into a wing like the blade of a propeller, and acts in a similar way, whirling round as the fruit falls, and retarding its passage to the earth, so that in a high wind the fruit may be carried some hundreds of feet. Note likewise the broad-winged fruit of the Elm. Of feathery appendages which serve the same purpose numerous examples occur to the mind: the Traveller's Joy, for instance, and the Pasque Flower, Reed-mace and many grasses. The brown heads of the Reed-mace, when ripe, consist of a vast number of tiny seeds, each on a delicate stalk, clothed with long slender hairs, which spread as soon as they are set free, so that the head fluffs out into a mass of downy fruit of surprising dimensions, which the wind carries in all directions. Most perfect of all, we have the beautiful parachute fruits of the Dandelion and its allies, and of some other plants. In the Dandelion the seed is small and cucumber-shaped. Attached to its upper end is a delicate stalk, which branches in umbel-like fashion into an exquisite hemispherical parachute, which represents, morphologically, the limb or free upper portion of the altered calyx. These appendages and the surrounding general involucre are hygroscopic, affected by varying degrees of moisture. Should rain come on before the fruit is launched forth on the [illegible] the little umbrellas fold up and the involucre closes round them and keeps them dry. When the sun bursts forth, the whole elaborate structure expands again, a breath of wind severs the fruit from its slight attachment to the receptacle, and away it floats. In many cases the attachment [illegible] light, so that [illegible] with an obstacle stops [illegible] para-chute is cast off and [illegible] damp crevice in the earth [illegible]

Water plays a less conspicuous [illegible] important part in seed dispersal. A river [illegible] continually bringing down seeds dropped into [illegible] plants along its banks, and in times of flood these are spread over adjoining low grounds. The seeds of many of the plants which fringe ponds and streams *float*, and even where no current exists, are drifted from one place to another by the wind. Eventually they sink, and germinate in the mud or sand which covers the bottom.

The part, intentional or unintentional, which animals take in the dissemination of seeds is nearly as important as that played by the wind. Just as the brightly coloured flowers are designed to attract insect visitors, so the use of scarlet berries is to attract birds, which, by eating them, may scatter the seed. Numerous experiments have shown that the vitality of the seeds contained in these juicy berries is not impaired by their passage through the birds' bodies. Moreover, digestion in birds is extremely rapid, and the seeds may be expelled within an hour of being eaten. The bright colour and sweet juiciness of the Strawberry and Cherry and Apple, then, corresponds in function to the brilliant petals and store of honey of the flowers; both the plant and its animal visitor reap material benefit from the visits of the latter, and hence the relation continues, and, presumably, spreads. But in most cases the plant is not so dependent on the animal for the successful accomplishment of this function of its existence as in the case of fertilization. If no birds eat the fruit, it will fall to the ground, perhaps be carried by wind or water to some distance, and may there germinate. Only in a few cases are the visits of birds almost indispensable. The parasitic Mistletoe appears to furnish a case in point. Without the presence of birds, which eat the fruit and distribute the sticky rejected seeds about the branches, the chance of one of the heavy smooth berries reaching and adhering to the branch of even a neighbouring tree appears remote indeed. The advantage to these berry-bearing plants, of fruit which will retain its juiciness, and its hold on the fruit-stem, for a long period, is sufficiently obvious. Long after most of the summer plants have shed their seeds, the hips and haws, the black berries of the Privet and the white ones of the Snowberry, brighten the bare branches, furnishing a welcome winter food-supply to the birds, and thus securing a wide and efficient dissemination.

Thus far regarding fruits which lay themselves out to attract animals. Many other plants effect dispersal by making animals the unknowing and sometimes unwilling carriers of their progeny. The fruits and seeds of such plants are usually distinguishable by the hooks and barbs that they bear, the object of which is to attach the seeds to the body of passing animals. The large heads of the Burdock, with their hooked involucre scales, are familiar to every child. Note that in this case it is the general involucre which bears the hooks. When ripe the whole head, containing many comparatively heavy fruits, is detached by adherence to the wool or hair of a passing animal. More often it is single fruits that bear hooked bristles or barbed hairs. Many instances occur in our [illegible] plants: examine, for instance, the fruit of the Bur Marigold, the Agrimony, Enchanter's Nightshade, Hound's-tongue. How effective a means of dissemination these hooked fruits furnish [illegible] a matter of common observation. I recollect picking over two hundred of the fruits of the Hound's-tongue off one stocking, after a stroll over the sand-hills that fringe the mouth of the River Boyne. Think how the sheep which graze on those sand-hills must carry the seeds far and wide. The experience of finding one's clothes full of the barbed fruits of the Enchanter's Nightshade on returning from an autumn walk in the woods is equally familiar to lovers of country rambles.

HOW ARCTIC ANIMALS TURN WHITE.

By R. LYDEKKER.

ALTHOUGH I have not the details of any one particular case before me, so many instances are chronicled in which the hair of human beings, under the influence of strong mental emotion due to terror or grief, has become suddenly blanched within a single night or some such period of time, that the occasional occurrence of such a phenomenon must apparently be accepted as a fact. Such a change is, of course, due to the bleaching of the pigment with which the hair is coloured, although we need not stop to enquire by what particular means this bleaching is accomplished; all that concerns us on the present occasion being to know that the hair in man may turn white in this manner under abnormal circumstances. And there appears to be evidence that under equally abnormal conditions a similar change may take place suddenly in the hair of the lower animals. This is exemplified by the well-known experiment made considerably more than half a century ago by Sir John Ross on an Arctic lemming—a small mouse-like rodent, which habitually turns white in winter, although dark-coloured in summer. In this instance the little animal was kept in a comparatively warm room till winter was well advanced, when it was suddenly exposed to a temperature of 30° below zero; a continued exposure to this and a still more intense degree of cold eventually resulting in its death, which took place within three weeks of the commencement of the experiment. In consequence of the conditions under which it had been kept, this lemming was still brown in mid-winter, when it ought to have been white. As a result of its first night's exposure, the fur on the cheeks and a patch on each shoulder became completely white, and by the end of the first week the whole coat had turned white. On examination, it was found that only the tips of some of the hairs had become blanched, and that these white-tipped hairs were longer than the rest of the coat, apparently owing to a sudden growth on their part in the course of the experiment. By clipping these long white-tipped hairs the animal was restored to its original brown condition.

Nothing is said with regard to any change of coat on the part of this lemming previous to the experiment, but it is probable that none occurred. It seems, however, to be clearly demonstrated that the tips of the hairs lost their colour by bleaching, induced by sudden exposure to the intense cold, and that the hairs thus blanched increased considerably in length in a very short period.

In spite of the very obvious fact that these changes occurred under extremely abnormal circumstances, it has been argued that Arctic mammals which turn white in winter do so normally by a similar blanching of the hair of the summer coat, and that the greater length of the winter, as compared with the summer dress of such white animals, is due to a lengthening of the individual hairs of the former.* Moreover, it has been inferred that the colour-change is directly under the control of the animals themselves. Quite apart from many other considerations, one weak point in this argument is that the hairs in the subject of the experiment were white only at their tips. It was doubtless assumed that had the experiment been continued over a longer period, the white would have gradually extended downwards till the whole hair became blanched. But had this been the normal way in which the change from a dark to a white coat is brought about, it is obvious that animals ought frequently to be captured in which the coat is in the same condition as that of the lemming. So far, however, as I am aware, no such condition has ever been described.

Moreover, it is perfectly well known that, apart from those which turn white in winter, a large number of animals have a winter coat differing markedly in colour, as well as in length, from the summer dress. The roebuck, for instance, is of a brilliant foxy red in summer, while in winter it is grey fawn with a large patch of pure white on the buttocks. And it is quite clear that the change from red to grey, and the development of the white rump-patch, is due to the shedding of the short summer coat and its replacement by the longer winter dress. Obviously, therefore, it is natural to expect that a similar change of coat takes place in the case of mammals which turn white in winter.

That the change in spring from a white to a dark dress is due to a shedding of the fur seems to be admitted on all hands, for it would be obviously quite impossible for long hairs to become short, or for white ones to turn brown. And even in animals which do not alter their colour in any very marked degree according to season the spring change of coat is sufficiently obvious. For the winter coat, owing to the long time it is worn and the inclemency of the season when it is in use, becomes much faded and worn by the time spring comes, and the contrast between it and the fresh and brilliant summer coat is very striking indeed. On the other hand, the summer coat is only worn for a comparatively short season, and that at a time of year when it does not become much damaged by the effects of the weather. Consequently no marked change is noticeable as the long winter hairs grow up through it; and it has accordingly become a common article of belief that, whether there is a change of colour or not, the long winter coat is produced by a lengthening of the summer dress.

Apart from the evidence of animals like the roebuck and many other deer as to the existence of an autumn change of coat, as deduced from a difference in colour, the fact of such a shedding of the fur is demonstrated by the circumstance that in many species, as, for instance, the mountain hare, the individual hairs themselves, as seen under a microscope, differ appreciably in calibre at the two opposite seasons of the year. In that species, for example, the hairs of the winter coat are of a much finer character than are those forming the short dress of summer, which are comparatively coarse and thick. Moreover, in spite of the natural tendency to believe in blanching on account of the aforesaid abnormal instances of turning white in a single night, there is abundant evidence to show that even in human hair the change from dark to white as age advances is

* *See* G. B. Poulton, "The Colours of Animals," chapter vii. (1900).

brought about by the replacement of dark hairs by white ones, and not by the bleaching of the former. In this case, however, the change, instead of being seasonal and sudden, is gradual and due to age. If the change was due to blanching, we should, of course, find some hairs which were partially white and partially brown (or black, as the case may be). And here it may be remarked that if such partially blanched hairs were met with, we should naturally expect to find that it would be the basal half which was white, and the terminal half which retained its natural colouring. In other words, precisely the reverse of the condition obtaining in Sir John Ross's lemming; thereby affording further presumptive evidence as to the abnormal condition of the change in that animal.

As a matter of fact, however, those of us who have reached an age when silver hairs have begun to make their appearance among the brown can easily satisfy themselves that such hairs are white throughout their entire length, and that a hair half white and half brown is quite unknown. From this we infer that the change from brown to white takes place in human beings by the gradual shedding of the dark hairs and their replacement by new ones from which pigment is entirely absent. So that normally there is no such thing as bleaching of individual hairs. The change is, indeed, precisely similar to that which takes place at the approach of winter in mammals that habitually turn white at that season, with the exception that, as a general rule, it is extremely slow and gradual, instead of being comparatively rapid, and also that the white hairs differ from their dark predecessors solely by the absence of colouring matter. Unfortunately, there is no subsequent replacement of the white hairs by dark ones!

The fact that the change from brown to white in the mountain hare (*Lepus timidus*) is really due to a change of coat and not to bleaching was known at a very early period to the English naturalist, Pennant; and the existence of this coat-change was likewise recognized by Macgillivray. It was not, however, till Dr. J. A. Allen, in a paper on the colour-change in the North American variable hare published in the *Bulletin* of the American Museum of Natural History for 1894, demonstrated by actual experiment the truth of Pennant's statement that the fact of the complete autumnal change of the coat in animals that turn white in winter was generally recognised by naturalists. So far as the spring change from the white to the brown dress is concerned, his conclusions are fully confirmed by Mr. G. E. H. Barrett-Hamilton, who communicated some interesting notes on the change in the European mountain, or variable hare to the *Proceedings* of the Zoological Society of London for 1899. The fact that the vernal colour-change is due to a shedding of the coat seems, however, as already mentioned, to have been much more generally admitted than was the case with regard to the autumnal transformation.

Dr. Allen arrives at the conclusion that both the autumn and the spring change take place periodically and quite independently of the will of the animal, and also that they are but little affected by phases of the weather, although they may be somewhat retarded or accelerated by the prevailing atmospheric temperature.

So far as the fact of the seasonal change being normally beyond the control of the animal in which it occurs, Mr. Barrett-Hamilton is in full accord with the American writer; but he goes somewhat further, and believes that it is quite uninfluenced by temperature, or at least by such variation of the same as may be met with in different parts of the area of the British Islands; and, as we all know, these are considerable."

"As in the case of many other animals (deer, for instance) the change from the winter to the summer coat takes place very late in the season in the mountain hare in Scotland, specimens undergoing the change being often taken early in May. But the date of the spring change is no earlier in the South of Ireland, where the climate is much milder, although the amount of whiteness assumed in that district is very much less than in the north. This seems to demonstrate the contention that temperature has little or no influence on the change so far as season is concerned.

That the animal has no control over the change from brown to white in autumn seems to be proved by instances referred to by Mr. Barrett-Hamilton, in which variable hares transported from Scotland and from Irish mountains to southern and low-lying regions continued for some seasons to appear in the northern garb of snowy whiteness. This persistence of the habit of turning white, even in unsuitable conditions, together with the lateness of the moult, resulted frequently in the curious spectacle of a mountain hare running about in all its conspicuous arctic livery under the bright rays of an April or May sun. After a few years such imported hares, or more probably their offspring, ceased to turn completely white, and the breed assumed the appearance of the ordinary hares of the southern locality to which they had been transported."

It would, of course, be extremely interesting to ascertain whether such transported individuals ever do give up the practice of turning white in winter, or whether it is only their offspring that do so; but, in any case, it is clearly demonstrated that the habit is very deep seated and difficult to overcome.

Very curious is the circumstance that the mode in which the coat is changed in the variable hare at the two seasons of the year differs *in toto* as regards the parts of the animal first affected. On this subject, with one verbal change in the first sentence, we may quote from Dr. Allen, who writes as follows:—

"In the fall the change begins with the feet and ears, the sides of the nose and the front of the head, which often become radically changed before the body is much affected; while as regards the body, the change begins first at the base of the tail and extreme posterior part of the back, and at the ventral border of the sides of the body, working thence upward towards the middle line of the back, and from behind anteriorly, the crown of the head and a narrow median line over the shoulders and front part of the back being the parts last changed. In the spring the order of change is exactly the reverse, the moult beginning on the head and along the median line of the anterior half of the dorsal region, extending laterally and gradually to the ventral border of the sides of the body and posteriorly to the rump, and then later to the ears and down the limbs to the feet, which are the parts last affected, and which often remain but little changed till the head and body have pretty completely assumed the summer dress."

It is very hard indeed to conjecture any satisfactory reason for this remarkable difference.

The American variable hare ranges, at ordinary levels, about as far south as Massachusetts, that is to say, nearly to the latitude of Madrid, and throughout the whole of this extensive tract it turns white in winter. On the other hand, owing to the much milder climate of western Europe the colour-change takes place in the mountain hares of Ireland, while it is reported that in those introduced into Ayrshire and the neighbouring counties of south-western Scotland the change is much less complete and regular than in those inhabiting the northern parts of the country.

An impression appears to be prevalent that in the more northern portion of their range both the mountain hare and the ermine (or stoat) are white at all seasons, but this does not seem to be authenticated.

Observations are wanting as to whether the changes of coat and colour in the mountain hare bear any relation to the appearance and disappearance of snow, or whether they occur regularly at the same season of the year. In the case of the ermine in the Adirondack region of New York, Dr. C. H. Merriam tells us that in this animal the white livery is assumed only after the first fall of snow, while the resumption of the brown does not take place till the snow begins to melt. Unfortunately, he says nothing in regard to change of coat. The late Dr. Coues stated, however, that in the case of the ermine the bi-annual change of coat takes place at the same season, but that it depends upon the condition of the temperature at the time whether the new coat differs in colour from its predecessor. In other words, the change from brown to white might be due either to shedding the coat or to bleaching of the hair subsequent to such shedding. The case of the mountain hare is, however, strongly suggestive that the colour-change is in all instances coincident with the shedding of the coat.

It is, of course, quite evident that the assumption of a white winter livery by mountain hares and ermines living in regions where the snow lies on the ground for a considerable portion of the year is for the purpose of rendering such animals as inconspicuous as possible when in their native haunts. And, so far as we know, such a change is universal among the species named when dwelling in high northern latitudes.

There is, however, another animal inhabiting the north polar regions of both hemispheres in which the change to a pure white winter dress is limited to certain individuals. The species in question is the Arctic fox, of which the beautiful fur, in both the white and the blue phase, is now much affected by ladies. That both the white and the blue individuals of this species are in the winter dress will be evident to every one who examines such furs carefully, the length and thickness of the hair being quite decisive on this point.

As it has been stated in several works that the white is the winter and the blue the summer phase of the Arctic fox, it may be well to quote from a letter written to me in answer to enquiries on this subject by Dr. Einar Lönnberg, of Upsala, whose observations are based on personal experience:—

The 'blue' foxes," he writes, "are uniformly dark-coloured summer and winter, and do not change to white at any time. In the summer they are very dark—dark brown in fact; in winter they are also dark, but more bluish. The individuals which turn white in winter are during the summer ashy grey on the upper-parts and sides, but have the tail, under-parts more or less of the flanks, and the ears and muzzle white. The distribution of the grey and white is, however, subject to individual variation. The 'blue' fox is in fact merely an [illegible] variety of the white one. Both breed together, and sometimes there are blue and white [illegible] in the same litter. A friend of mine

observed on Bear Island a pair in which the female was white and the male blue. In Iceland it is stated that the Arctic foxes are blue."

With this single exception it appears that the white and the blue phase are met with throughout the habitat of the species. In other words, the animal is dimorphic, if it be permissible to apply this term to a case where the difference between the two phases of a species is restricted to coloration.

What makes the matter so puzzling is that if "blue" foxes are able to thrive during winter in a snow-clad country, what necessity is there for their fellows—and, indeed, for any species—to turn white at that season of the year?

THE WHITE NILE—FROM KHARTOUM TO KAWA.

AN ORNITHOLOGIST'S EXPERIENCES IN THE SOUDAN

By HARRY F. WITHERBY, F.Z.S., M.B.O.U.

III.—THE COUNTRY AND THE PEOPLE

My last article* treated of the river and the stretches of grass and mud bordering upon it. Fringing the mud and stretching inland, for half a mile or so in most parts, but in some places for two miles, is a belt of wooded country. The trees composing this belt are chiefly of the acacia family, many of them being of a gum-bearing species, and under and around them is a thick undergrowth of mimosæ, cacti, and other bushes. At the time of our visit the trees and shrubs, with few exceptions, were practically bare of leaves, so that, had it not been for the thickness of the trees there would have been but little cover.

Vegetation seemed entirely at a standstill, and the hot season might well be termed the winter in this district, especially as the general breeding season for the birds was over. Of the 141 species of birds which we identified only four or five appeared to be nesting. A small lark, which lived on the ground and continually sought the shade of some bush, made the neatest little nest in the dry mud by the river. The nest was a small shallow "cup" composed of dry grass and a few bits of cotton, while round the cup was a compact and neatly-arranged layer of particles of mud. Only one egg was laid. Two species of doves were also nesting. The nest and eggs of one‡ of them were much like those of our Turtle Dove. The other,§ which was a pretty little long-tailed bird, built an exceedingly slender nest even for a dove. It was round in shape and only 3½ inches in diameter. The two eggs were of a dark creamy colour. The young were most quaint objects lightly covered with whitish down. The smallest of the many shrikes which we found was the only one breeding. I watched a pair at work on their neat chaffinch-like nest, which was placed in a fork of a horizontal bough some 30 feet up an acacia. The birds brought material at intervals of a minute or less during the considerable time I watched them. They invariably sat in the nest and turned rapidly round in it as they built in each mouthful of stuff which they brought. The outside of the nest they plastered with cobwebs.

As the dry season affects the foliage of the trees, so does the river influence their growth. When the river is at its greatest height many of the trees on its flat

* KNOWLEDGE, June, 1901.

† [illegible] (L.)

‡ *Turtur ambiguus*, Boc.

§ *[illegible]* (Lath.)

banks are flooded half way up the [illegible]. The trees are numerous and of a fair size, but they quickly decrease in number and height as one [illegible]; they grow from the water, and are soon replaced by tall bushes. The bushes struggle onwards, becoming gradually smaller and getting thinner, until they finally succumb to the want of water. Beyond, as far as the eye can see, stretches a flat desert with here and there a thorny leafless bush or a clump of withered grass, while near and far the deceitful mirage sets forth its enticing pools and ponds and lakes, a mock vegetation and a mock water in a merciless fiery land. This desert is formed for the most part of a grey and gritty cotton-soil, but in a few places it is of a true yellow sand.

At several points in our route there were "stations," where a large amount of wood is cut and collected for

FIG. 1.—Building a Square Brick Hut. The bricks in the foreground are baking in the sun.

the use of the steamers. Notwithstanding the scarcity of timber near Khartoum, and the fact that no other fuel is available, the gangs of natives employed to chop this wood were not then under sufficient supervision. The consequence was that much wood had been wasted and many fine trees ruthlessly maimed. We often passed a mile or two of stumps four or five feet high left in the ground, and so many of the best trees had been mercilessly lopped by the careless and ignorant natives that near these wood stations it was often impossible to find shade for our tents. I was assured, however, at Omdurman, that the method of cutting the timber would shortly be improved.

The mimosa bushes, which form the dense undergrowth, are thickly covered with thorns of three to five inches in length, exceedingly sharp and strong, and of a dazzling white as though they were enamelled. As we ran short of pins we found these thorns exceedingly useful in packing our bird skins, but they made the country difficult to "negotiate." One was driven through my boot into the foot, another pierced the leg of one of my companions, and a third completely lamed a donkey for a month. The acacia trees, too, are plentifully provided with smaller but no less annoying thorns, and there are but two varieties of bushes without them.

Perhaps I have not drawn a very enchanting picture of the country it was our good fortune to work in, yet, notwithstanding its undoubtedly monotonous character and the lack of the pleasing colours and sun effects of Egypt, there is a peculiar fascination about this country near Khartoum. Its very extent and barrenness are a charm and confer an exalted idea of freedom on the

traveller [illegible] natural to search [illegible] with an exaggerated [illegible].

The natives of th[illegible] the tree. Every village of any [illegible] on the bare desert with no protect[illegible] sun or scorching wind. In the [illegible] there were always to be found large patches of ground used as cemeteries. The graves were the slightest mounds, having a stone, or a stick with a piece of white cloth tied to it, planted at either end, while a number of broken pitchers were placed bottom upwards here and there amongst the graves. The huts composing the larger villages were usually round in shape with conical straw roofs, the walls being built with bricks, which are burnt only by the heat of the sun. Some were square with flat roofs built in the same way as the majority of those in Omdurman, while a few had a rough verandah in front. All along our route, however, there was a great number of people living in very small huts which could be "struck" and moved about almost as easily as tents. These huts varied in shape and in the material with which they were constructed. Some were round with conical roofs and were entirely made of "dhura" straw, while a few were dome-shaped. The majority, however, were oblong, measuring about 6 feet broad and 7 or 8 feet long. These were not more than 5 feet high, and had flat roofs usually made of straw or matting, but sometimes of fodder, so that more than once a native sold us half his roof as food for our camels. Straw, cane matting, or cloth was used indiscriminately for the walls. The rough cloth used for this purpose is made of a mixture of goats' hair and sheep's wool, which is spun by the women on to a rough spindle in the same way that they spin cotton. A primitive loom is made on the ground with poles held in position by pegs driven into the sand, and the women while weaving squat down under a temporary sun-shelter. These movable dwellings were sometimes placed under trees,

FIG. 2.—A Dome-shaped H[illegible]

but generally in the open, [illegible] were seldom more than six or eight tog[illegible]. The natives inhabiting them were very shy, and [illegible] when we pitched our tents near an encampment the people were soon busy rolling up the matting and cloth forming the walls of the huts, and in a few hours disappeared, carrying away their roofs by the four corner poles, their rolled-up walls and all their goods and chattels. When asked why they moved away from us they gave no reason beyond remarking that they objected to our tents being near them.

In two or three places we found natives living in a much rougher sort of hut, built under very thick bushes which had been cut out in the middle and thickened on the outside, thus forming natural "Zareebas."

The reason for such diversity in dwellings lies in the mixed character of the population of this stretch of country. Arabs and blacks of many tribes inhabit it, and although rather thinly populated, the people were so evenly distributed along our route that we were scarcely ever out of sight of a native. At the time of our visit the men were enjoying idleness, but the women were always hard at work carrying water or grinding corn. The corn is placed upon a wide and heavy stone and is then ground with a smaller stone, which is rubbed and rolled backwards and forwards. The stones wear away rapidly, and a family must actually consume a goodly number in a lifetime. The boys are also kept busy shepherding the goats and sheep, which are in thousands all over the country. These animals are very rarely slaughtered and are kept merely for their milk. In the wet season, of course, conditions are entirely changed, and the men are busily employed growing "dhura," maize, cotton and other produce. At the end of the dry season food becomes so scarce that the goats are fed upon the roots of the grass, the grass being hoed up, and the roots beaten soft with short wooden clubs.

Near the large villages we found the natives decidedly independent and difficult to get on with. In the smaller villages and isolated communities the dress, or rather the greater want of dress, at once showed the people to be of a more unsophisticated nature. They greeted us with many salaams and much kissing of

Fig. 3.—A Native Loom.

hands, and were more willing to give us such supplies as they could but very little work could be got out of them.

At every camp we harangued the "Sheikh" of the nearest village and asked him to procure us animals for our collection, but we stipulated that they should be brought in alive and uninjured. We offered varying rewards, but at only one camp did the natives show any interest or take any trouble to earn the reward. At this camp, near a rocky hill named Gebel Auli, the natives brought us a number of bats and some rather rare hedgehogs, caught in the caverns on the hill. The bats were brought by a boy who appeared with his shirt bulging out and held up to his neck. Out of the shirt were extricated amidst considerable amusement and excitement, half-a-dozen live bats with long and very sharp teeth, which were more than once used with great effect. The bats were swarming in the cracks and caverns of Gebel Auli, and their squeaking could be heard at a considerable distance. The natives poked long sticks into the cracks and out flew the bats, which

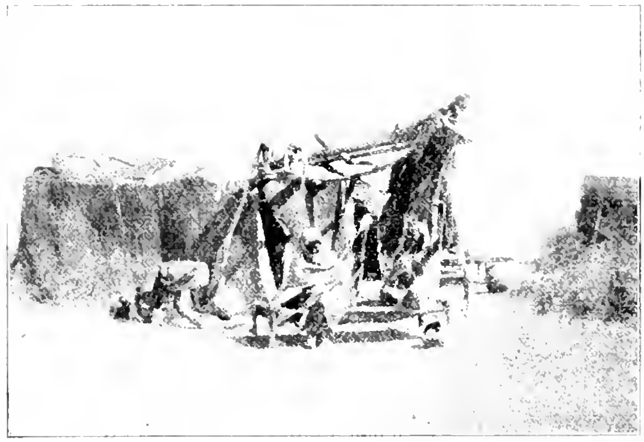


Fig. 4.—A Movable Hut made of Matting. The woman on the left is grinding corn, while the two seated on the "angarib," or native bedstead, are spinning.

were knocked down with cloths. The hedgehogs which were brought to us from this same hill were exceedingly pretty little beasts with dark spines and white hair. On them we discovered some elegant yellow fleas, which I gave to Mr. Charles Rothschild, who collects these parasites. He proclaims them a new species, and has done me the honour of naming them *Pulex Witherbii*!

In general, however, the offer of a reward for animals would produce great keenness among the natives for only a day or so. They would bring in any number of the common rats of the country and, although we stipulated for live animals, every bone, skull, or bit of skin that could be found would be brought in the hope of reward. But when they found that we needed no more of the rats that swarmed in their huts, these very lazy natives returned to their normal occupation of sleeping and eating and refused to hunt any further. This seems extraordinary, because luxuries to a certain extent can now be bought for money in the markets of all the larger villages through which we passed.

In the days of the Khalifa it was rather a disadvantage for a man to become prosperous. The tyrant would soon hear of it, sweep down upon him and carry off his flocks and corn. As several natives said to us when we asked them why they refused the money we offered for goats' milk: "The Khalifa never took the milk, he always took the goats unless they were driven away and hidden. Now you come and only want the milk and offer to pay for that!" No doubt they think the English fools.

Although singularly uninquisitive the natives provided one of the trials of collecting by their ubiquity. One could never be sure on shooting at a bird whether a concealed native would not rise from behind a bush in the line of fire at the moment.

We never actually shot anyone, however, although there were many narrow shaves. The traps which we set for mammals, although carefully concealed, seldom brought us profit. Goats tramped over them, natives stole them, presumably for the copper wire of which they were made, and dogs dragged them away for the meat with which they were baited.

These dogs, as is usual in Africa and the East, are never fed, and consequently become very bold and expert thieves. I had the misfortune to be ill in our first camp, and the dogs used to creep into my tent at night and drink the milk at my bedside.

Another visitor, but a pleasing one, appeared in the daytime. This was a little bird—the Lesser Whitethroat*—a summer visitor to England, and exceedingly numerous during our winter and spring on the White Nile. The Whitethroat came to my tent for water, a bucket of which was kept near my bed. On the very first day of my illness this bird found out the water and came into the tent, perching on the bed or my arm. It stayed there most of the day, and whenever I splashed my hand in the water it would hop down my arm and suck the drops of water from my finger tips. The bird was always thirsty, and although the river was quite near it seemed to prefer to drink in this way, and so I was amused by this delightful little bird all through the heat of the day. I missed it much on moving from this camp.

The extreme dry heat of the country affects the birds perhaps more than other animals. All the land birds, large and small, almost always kept their mouths open as though gasping in the heat. Yet they sing, some of them as beautifully as our songsters, and seem as happy as birds usually are. We used to take advantage of their propensity to drink as a means to entice them within range of the camera. A tin of water was placed in the sand at a few yards distance from the camera, which was kept focussed, and ready for action whenever a bird came to drink. In this way many interesting photographs were apparently secured, but alas, on development, all my "photographs" proved complete failures. Messrs. Dallmeyer had carefully fitted up for me one of Messrs. Watson & Sons' "Gambier Bolton" cameras with telephoto lenses. The camera proved strong enough to resist the heat and the camels, and would no doubt have worked very well had I taken plates and risked the great chance of their being broken. I chose, however, to take films, which became seriously affected by the great heat, and were, moreover, defective in the making as regards the emulsion. For this ruinous defect the maker deserves to be named. Such a defect could, of course, be guarded against by testing each batch of films before starting, but the fogging due to the heat cannot be avoided. I think it wise to mention this because, although I am well aware that films are often perfectly successful in very hot climates, they are as often not, and the successes are well advertised while the failures are seldom reported. Half the number of plates in such a climate would be more certain to yield success if very carefully packed than twice the number of films.

Only the common and boldest birds came down to the tin of water to drink and be photographed. Of these a species of Bulbul,** a bird a little larger than a Robin, with a black head, a brown back, and a white breast, was the most [illegible] and usually the first to try the experiment. One [illegible] of these birds were always in the trees over our camp, and their pleasing flute-like notes, almost exactly [illegible] the words "tit-willow," were continually to be heard.

* *Sylvia curruca* (Linn.) ** *Pycnonotus arsinoe* (Hempr. et Ehr.)

THE BRIGHTNESS OF STARLIGHT.

By J. E. Gore, F.R.A.S.

It is probably a matter of common observation that on a clear moonless night it is never absolutely dark, even at midnight; a certain amount of light is given by the stars. What does this light amount to in terms say of full moonlight? Miss Clerke, in her "System of the Stars," gives the light of all stars down to $9\frac{1}{2}$ magnitude as about 1-80th of full moonlight. M. G. l'Hermite found starlight equal to 1-10th of moonlight, but this estimate is evidently too high. The difference between a bright moonlight night and one illuminated by starlight alone is very considerable.

Let us make an attempt to estimate the total amount of starlight by computing the light emitted by all the visible stars down to the faintest point visible in the largest telescopes, like those of the Yerkes and Lick Observatories. The data available for this calculation are rather uncertain, but an approximation to the truth may perhaps be possible.

To express the total amount of starlight in terms of the light of a star of zero magnitude, like Arcturus, and thence in terms of moonlight, let us assume—as is now admitted by most authorities on the subject—that the total number of the visible stars is about 100 millions. Let us also assume that the "light ratio" is 2.512 (now accepted by all astronomers)—that is, that a star of zero magnitude gives 2.512 times the light of a star of the 1st magnitude, a star of the 1st magnitude 2.512 times the light of a 2nd magnitude star, and so on. To enable us to make this calculation it will be necessary to estimate the number of stars of each magnitude down to the 17th magnitude, which is about the faintest visible in the great Yerkes telescope. Dr. Gould, in his *Uranometria Argentina*, gives the following formula for computing the total number of stars visible in both hemispheres to any given magnitude, m.

$$\Sigma_m = 1{\cdot}0051 \times (3{\cdot}9120)^m$$

From this I find the following:—

Magnitude.	No. of Stars.	Magnitude.	No. of Stars.
To 1.0 inclusive	3·93	To 10.0 inclusive	843,718
,, 2.0 ,,	15·71	,, 11.0 ,,	3,283,876
,, 3.0 ,,	60·17	,, 12.0 ,,	12,911,448
,, 4.0 ,,	235·1	,, 13.0 ,,	50,511,900
,, 5.0 ,,	920·9	,, 14.0 ,,	197,602,545
,, 6.0 ,,	3602·5	,, 15.0 ,,	773,021,071
,, 7.0 ,,	14,093	,, 16.0 ,,	3,024,057,632
,, 8.0 ,,	55,131	,, 17.0 ,,	11,830,114,720
,, 9.0 ,,	215,671		

From this it will be seen that the formula gives for the fainter stars numbers enormously too large. For the brighter stars, viz., those of the 6th magnitude, the numbers seem to be rather small. Houzeau, who observed himself all the stars visible to the naked eye in both hemispheres, gives the following figures:—

Magnitude.	No. of Stars.
1	20
2	51
3	200
4	595
5	1213
6	3640
Total	5719

Accepting those figures, and adjusting the remaining magnitudes to suit a total of 100 millions down to the 17th magnitude, we obtain the following table:—

1. Magnitude.	2. No. of Stars.	3. Light of each Star in terms of zero mag.	4. No. of equivalent Stars.	5. Remarks.
Above zero	2		7	Sirius and Canopus.
Zero mag.	1	1	1	Arcturus.
0 ½	5	$\frac{1}{2.512}$ [illegible]	4	Capella, Vega, α Centauri, Rigel and Procyon.
½ 1½	13	$\frac{1}{2.512}$ [illegible]	5	
1½ 2½	51	$\frac{1}{2.512}$ [illegible]	8	
2½ 3½	200	$\frac{1}{2.512}$ [illegible]	13	
3½ 4½	595	$\frac{1}{2.512}$ [illegible]	15	
4½ 5½	1213	$\frac{1}{2.512}$ [illegible]	12	
5½ 6½	3640	$\frac{1}{2.512}$ [illegible]	14	To this magnitude, 6½, the numbers of the stars in each class have been assumed from Houzeau's results. The numbers in the fainter magnitudes have then been roughly adjusted so as to make the total about 100 millions. This may seem a rather arbitrary proceeding, but there is evidence to show that the stars really "thin out" below the 11th magnitude.
6½ 7½	15,000	$\frac{1}{2.512}$ [illegible]	24	
7½ 8½	50,000	$\frac{1}{2.512}$ [illegible]	31	
8½ 9½	160,000	$\frac{1}{2.512}$ [illegible]	40	
9½ 10½	628,000	$\frac{1}{2.512}$ [illegible]	63	
10½ 11½	2,440,000	$\frac{1}{2.512}$ [illegible]	97	
11½ 12½	6,000,000	$\frac{1}{2.512}$ [illegible]	95	
12½ 13½	10,000,000	$\frac{1}{2.512}$ [illegible]	64	
13½ 14½	14,000,000	$\frac{1}{2.512}$ [illegible]	35	
14½ 15½	18,000,000	$\frac{1}{2.512}$ [illegible]	18	
15½ 16½	22,000,000	$\frac{1}{2.512}$ [illegible]	9	
16½ 17½	27,000,000	$\frac{1}{2.512}$ [illegible]	4	
Totals	100,198,093		559	

It will be noticed that the numbers in column 4 of the above table rapidly diminish for the fainter magnitudes. If there were 100 millions of stars of the 20th magnitude their combined light would be only equal to that of a single star like Arcturus. From this it is clear that the light of all the stars below the 17th magnitude may be safely neglected.

In addition to the stars there are a large number of nebulæ scattered over the surface of the heavens, but the majority of these are such faint objects that their combined light must be inconsiderable. Assuming a total number of 120,000 nebulæ and an average brightness for each equal to that of a star of the 8th magnitude, we have their combined light equal to 30 stars of zero magnitude. Hence the total light of all the stars and nebulæ in both hemispheres would be equivalent to that of 589 stars of zero magnitude like Arcturus. This estimate, of course, includes the Milky Way.

Now to find what fraction this is of moonlight we must consider some estimates which have been made of sunlight and moonlight. Huygens in the 17th century found the sun 756,000,000 times brighter than Sirius; Michell in 1767 found 9,216,000,000; Wollaston in 1825-6, 20,000,000,000; Von Steinheil in 1836, 3,840,000,000; G. P. Bond in 1861, 5,970,500,000; and A. Clark found 3,600,000,000. The mean of all these rather discordant measures is:—

Sun's light = 7,230,000,000 times light of Sirius.

Modern photometric measures make Sirius about four times the brightness of Arcturus, and hence we have

Sun's light = 28,920,000,000 times light of zero star.

Comparing sunlight with moonlight, Bouguer found the sun 300,000 times the brightness of full moonlight; Euler found 374,000; Wollaston 801,072; G. P. Bond 470,980, and Zöllner 618,000. The mean of these is 512,810, but Zöllner's estimate of 618,000 is the one now generally accepted. Assuming this value, we have—

$$\text{Moonlight} = \frac{28{,}920{,}000{,}000}{618{,}000}, \text{ or}$$

Moonlight = 46,800 times light of star of zero magnitude.

$$\text{Hence starlight} = \frac{589}{46{,}800} = \frac{1}{80} \text{ of moonlight.}$$

This result gives for *one* hemisphere (which is all that is visible from one place at one time)

$$\text{Starlight} = \frac{1}{160} \text{ of moonlight.}$$

And this is probably not far from the truth.

An examination of the table will show that the combined light of the stars below 6½ magnitude is considerably greater than the light of those above that magnitude, so that if all the stars visible to the naked eye were extinguished we should still have nearly the same amount of starlight.

CONSTELLATION STUDIES.

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

VIII.—THE ARCHER AND THE WATER-BEARER.

THE constellation of Sagittarius, when on the meridian, is almost entirely above our English horizon, but it lies so low that it is perhaps less familiar to us than any other of the zodiacal signs, for though Scorpio does indeed lie lower still, its brilliance has made it better known. Still, there is no difficulty in recognizing it on a very clear night, at its culmination, which takes place at midnight at the end of June. The old rhymester directs us:—

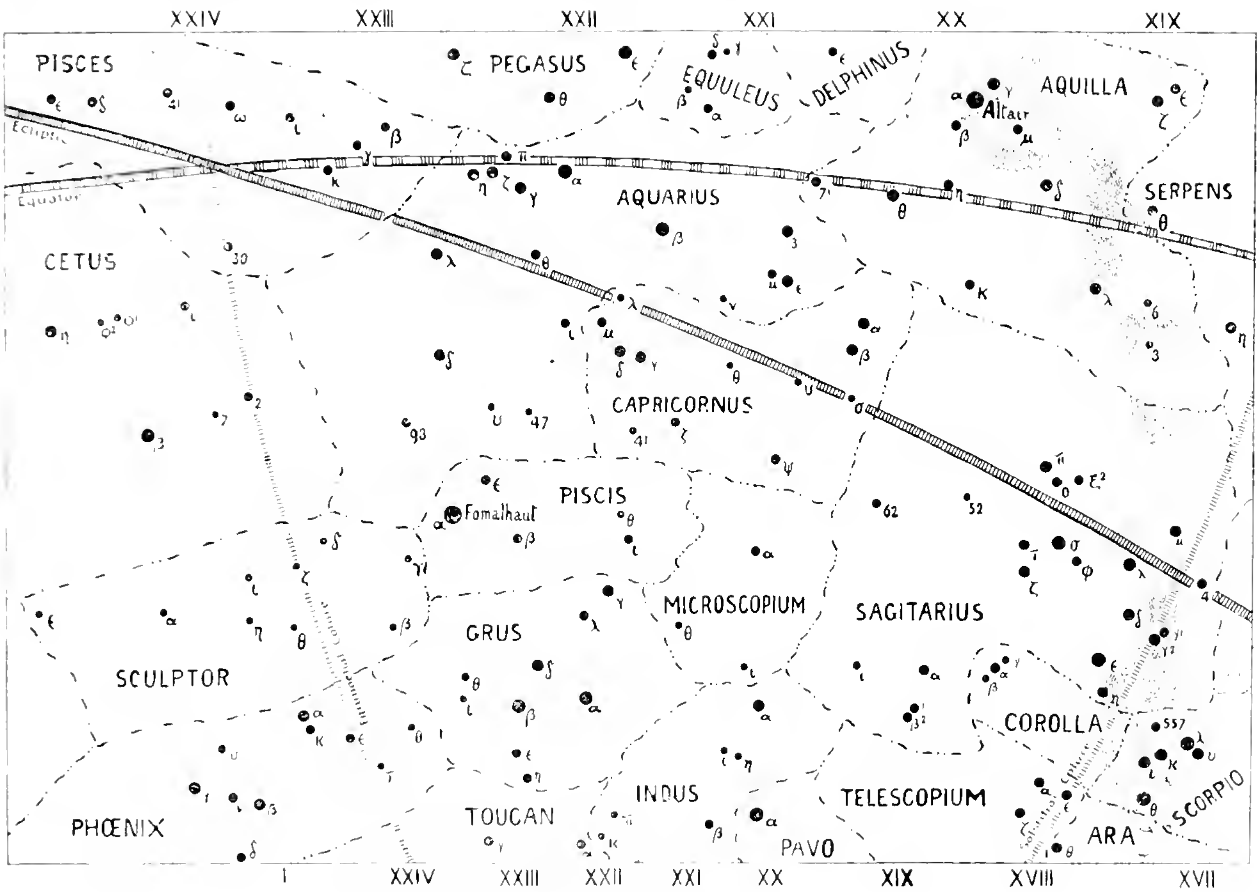
"From Deneb, in the stately Swan, describe a line south-west
Through bright Altair in Aquila, 'twill strike the Archer's breast."

Or, most strictly speaking, his shoulder, marked by the bright star, Sigma. A little in advance of Sigma are five bright stars in an undulating line on the eastern branch of the Milky Way, which here suffers one of its numerous divisions. Proceeding from the most northerly of these downwards, they are lettered Mu, Lambda, Delta, Epsilon, Eta, and mark the position of the Archer's Bow. A pair of stars, both bearing the letter Gamma, a little in advance of Delta, marks the point of the Arrow which the Archer is discharging at the Scorpion, whilst Zeta, a bright star a little below Sigma, marks the wing of the Arrow. A little triangle of stars, Xi, Omicron, Pi, mark the neck of the figure, and practically exhaust the list of its brighter stars. Alpha and Beta, the latter a wide double star to the eye, are in one of the hind legs of the Man-horse, but are below our English horizon.

But though Sagittarius is not a distinguished constellation, viewed as a whole, it is very rich in objects of the greatest interest in opera-glass or telescope. Mu, the upper horn of the Bow, is the centre of a region as rich in star clusters as the nebulous region in Virgo is in nebulæ. A wonderful object, number 8 in Messier's catalogue, forms a rhomboid with Mu, Lambda and Delta. North of Mu lies number 24 of the same catalogue, a star cluster quite unlike Messier 8, but almost as attractive. Passing upwards in the same straight line, we come to Messier 18, then Messier 17, the famous "horse-shoe" nebula, and a little further off, Messier 16. These clusters are the principal objects in the little modern constellation, Scutum Sobieski, a little asterism which Hevelius devised to celebrate the valiant John Sobieski, king of Poland, and deliverer of Europe from the Turk. Proctor and some other modern map makers omit the constellation entirely, and for the sake of simplicity it is well that it should be so. As designed, it filled a small triangular space between Serpens, Aquila and Sagittarius. It was practically entirely enclosed

The constellation lies below our English horizon with very little to mark it from any point.

The next zodiacal constellation to Sagittarius is Capricornus, small and easily found. Just as Sagittarius is a centaur or man-horse, so Capricornus is almost invariably a goat-fish. The goat has usually been explained as signifying the sun at the winter solstice, seeing that after that season has passed the sun begins again to move upward in the sky; the rock-haunting goat or ibex being adopted as the symbol of the climbing motion of the sun, whilst the fishtail pointed to the rains and floods of midwinter. We know, however, that the constellations were mapped out many centuries before the winter solstice fell in Capricorn, and that the explanation, however ingenious, was but a late guess, made when all actual recollection of the meaning of the sign had been lost.



Star Map No. 8; The Region of the Archer and the Water-bearer.

within the borders of the Galaxy, and contains but a single notable star, the variable R. Scuti; but its wealth of telescopic stars, clusters and nebulæ is most remarkable. Sir William Herschel estimated that in five square degrees of space it contained one-third of a million of stars. Of its clusters the most wonderful is just visible to the naked eye, and is Messier 11, the "Flight of Wild Ducks," on the north-eastern border of the constellation.

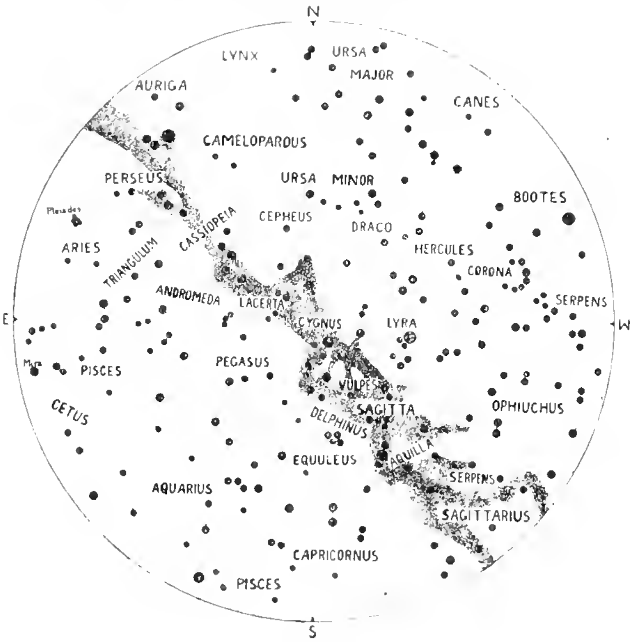
The fore-feet of Sagittarius are often not shown in the designs of this constellation, the place where they should come being occupied by the Southern Crown:

> "Other few,
> Below the Archer, under his fore-feet,
> Led round in circle, roll without a name."
> (Brown's *Aratos*.)

Capricorn may be found by drawing a straight line from Vega through Altair. Omega Capricorni lies just as far below Altair as Vega lies above it, and marks one knee of the kneeling goat. Psi, immediately above, lies almost on the straight line from Altair, and Alpha and Beta, which mark the root of the horns and the eye of the animal, are but little in advance of the line, only considerably higher up. Alpha is Algedi, which simply means "the goat"; Beta is Dabih, the slaughterer. The first of these stars is a visual double, and it is interesting to note that it has become so comparatively recently. The two stars have no real connection with each other and their proper motion is carrying them apart by something more than a minute of arc in a thousand years. Beta Capricorni is also a beautiful double in the opera-glass, the fainter star being of a sky-blue tint. The only other stars of any great brightness in the constellation are Zeta, Gamma and Delta, which mark the fishtail. Delta is indeed the brightest star in the whole asterism, and bears the name Deneb Algiedi, the "tail of the goat." Following Zeta by about the same distance that Alpha is from Beta, the opera-glass will show as a faint point of light 30 Messier, a large cluster of remarkable richness.

"Down from bright Vega, cast your glance across the Dolphin's space
Then just as far again you'll find the Waterbearer's place."

Aquarius is one of the straggling constellations, and pretty nearly overwhelms Capricornus. He has been figured from time immemorial as a man pouring out a stream of water from a pitcher; but for some reason, which is now lost to us, his right arm is stretched backwards to the fullest extent possible so as to reach over almost the entire length of Capricorn. The figure is by no means clearly marked out in the main. The stream from the pitcher can be traced in the number of faint



The Midnight Sky for London, 1901, August 5.

stars in the eastern portion of the constellation, which lead downward in wavering curves to Fomalhaut, a star of the first magnitude and one of the four ancient Royal Stars. Dwellers further south can recognize Fomalhaut without any difficulty, since Achernar lies just mid-way between it and Canopus. But at 2 o'clock in the morning in the present time of the year it is impossible for English observers to mistake the star; it lies low down on our southern horizon without any serious competitor near it.

Its name Fomalhaut simply means "the Fish's Mouth," for strangely enough through all the long centuries that the starry symbols have come down to us, Aquarius has always been shown as pouring forth his stream of water into the mouth of a fish; surely the strangest and most bizarre of symbols.

Fomalhaut, Beta Capricorni and Alpha Aquarii form the points of a triangle which is nearly equilateral. Alpha Aquarii is known as Sadalmelik, the "fortunate star of the King"; Beta Aquarii, one-third of the way from Alpha Aquarii to Beta Capricorni, is Sadal Sud, "the luckiest of the lucky," supposed to refer to the good fortune attending the passing of winter. Alpha and Beta mark the two shoulders of the waterpourer, and three bright stars near Alpha, Gamma, Eta and Pi, with a fourth, Zeta, almost in the centre of the triangle, mark the body of the pitcher from which Aquarius is pouring.

The outstretched arm of Aquarius is marked by a slightly curved line of stars extending from Beta Aquarii to Alpha Capricorni. Two fairly bright stars, Mu and Epsilon, near Alpha Capricorni, give the place of the Waterbearer's hand. In the middle of the arm is Nu, a much fainter star, and about a degree and a half preceding it. Just barely within the power of an opera-glass to reveal it as a faint point of light, is one of the most wonderful of the planetary nebulæ. Midway between Alpha and Beta Aquarii, but above the line joining them, is M. 2, in the head of the Waterpourer; "a heap of fine sand" where each grain is a sun.

Those who have the opportunity of observing from southern or equatorial regions, will find the brightest and most easily recognized of all the new constellations due to Dircksz Keyser, just south of Piscis Australis, the constellation of which Fomalhaut is the chief star. This is Grus, the Crane, and five bright stars distributed at equal distances along a gentle and regular curve, whilst a bright second magnitude star precedes them, form its principal characteristics. The Microscope, interpolated by Lacaille between Sagittarius and Piscis Australis, and the Sculptor's Tools, now more generally known as the Sculptor, which he added below Aquarius, are as destitute of features of interest as the designs are of appropriateness to their celestial surroundings.

PHOTOGRAPHS OF THE NEBULÆ H V. 32 ORIONIS, H IV. 2 MONOCEROTIS, H IV. 28 CORVI, AND H I. 139 (M. 61) VIRGINIS.

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

NEBULA H V. 32 ORIONIS.

R.A. 5h. 1m. 57s. Decl. 3° 29'·4 South. Epoch 1900.

Scale—one millimètre to twelve seconds of arc.

References.

N.G.C. 1788. G.C. 1005. *h* 347. H V. 32. Rosse, *Obs. Neb. and Cl.*, p. 46.

The photograph was taken with the 20-inch reflector on February 28th, 1899, between sidereal time 5h. 44m. and 8h. 4m., with an exposure of the plate during two hours and twenty minutes, and it shows the nebula to be cloud-like in form and extending in *north preceding* to *south following* direction with fainter nebulous extensions towards the *north following*. There are dark areas which indicate that we can see, through gaps in the nebulosity, into the lightless void beyond it; the larger gap being on the south and *south preceding* sides, with a solitary faint nebulous star-like condensation near its centre.

One star of about 9th magnitude with a *comes* of 13-14 magnitude are apparently involved in the northern part of the nebula, and in the *south following* end is an apparently nebulous star of about 10-11 magnitude; there are also seven or eight stars of less brightness than 13th magnitude contiguous to the nebulosity; some of them are

PHOTOGRAPHS OF NEBULÆ

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

S

H V. 32 Orionis.

H IV. 2 Monocerotis

P. F

H IV. 28 Corvi.

M 61 Virginis.

N

involved in it. The brighter stars may not be involved in the nebula but seen in alignment with it.

There is no indication that the nebula has great depth, but rather that it resembles a relatively thin cloud which can partly be seen through, and the two bright stars apparently involved in it have projections of nebulous matter extending from them which somewhat resemble the projection from the star *Electra* in the *Pleiades*. In order to see these appearances clearly it is necessary to examine the original negative, for they are too faint to be reproduced on paper prints.

NEBULA H IV. 2 MONOCEROTIS.

R.A. 6h. 33m. 42s. Decl. 8° 49'·3 North. Epoch 1900.

Scale—one millimetre to twelve seconds of arc.

References.

N.G.C. 2261. G.C. 1437. *h* 399. H IV. 2. Rosse, *Obs. of Neb. and Cl. of Stars*, p. 53. *Phil. Trans.*, 1833, Pl. XIV., Fig. 64, and 1850, Pl. XXXVII., Fig. 10. Lassell, *Mem. R.A.S.*, Vol. XXIII., Pl. II., Fig. 8.

The photograph was taken with the 20-inch reflector on January 27th, 1900, between sidereal time 3h. 43m. and 5h. 13m., with an exposure of the plate during ninety minutes, and it shows the nebula to be in form like a fan, or comet, with a star of about 11th magnitude at the apex. There is faint nebulosity with structural characteristics on the *north preceding* side, and an extension, like a streamer, on the *north following* side. The nebula resembles the two that are near *Gamma Cassiopeia* (pub. in Knowledge, May, 1898; and in *I.R. Pho. of Neb. and Cl. of Stars*, Vol. II., Pl. XXV.). It also resembles the nebula H I. 143 *Virginis*. Two or three condensations are visible in the nebulosity. In the *Phil. Trans.*, 1850, Pl. XXXVII., Fig. 10, Lord Rosse has given a drawing of this nebula on which is shown a ring separating the apex from the body, but the photograph does not indicate that appearance.

NEBULA H IV. 28 CORVI.

R.A. 11h. 56m. 46s. Decl. 18° 19'·2 South. Epoch 1900.

Scale—one millimètre to twelve seconds of arc.

References.

N.G.C. 4038-9. G.C. 2670-1. *h* 1052-3. H IV. 28.

In these references the nebula is described as two nebulæ, but Lord Rosse, in the *Phil. Trans.*, part 3, 1861, p. 724, Pl. XXVII., Fig. 18, depicts and describes it as a spiral which in outline corresponds with the photograph hereto annexed.

The photograph was taken with the 20-inch reflector on April 25th, 1900, between sidereal time 11h. 42m. and 13h. 12m., with an exposure of the plate during ninety minutes, and it shows the nebula to be a right-hand spiral with fourteen or fifteen star-like condensations involved in the convolutions, one of which (or probably two or three images overlapping), forms the nucleus, and there is shown on the negative extensions of faint nebulosity in the *north preceding*, south, and *south following* directions. There are some deviations from the symmetrical form on the *north preceding* side, both in the convolution and in the star-like condensations involved in it, and ere long, measurements of the position angles, distances, and fiducial places of reference between the condensations and some of the normal stars surrounding the nebula will be published. Then by aid of the photographs, of diagrams, and of tables of measurements from such fiducial stars, the astronomers of the future will be well equipped for finding out the changes and the progressive development of this and of other sp[illegible] into star-clusters, or else into systems of stars [illegible] innumerable curves and lines of stars which [illegible] revealed to us as large constituents of th[illegible] Milky Way. I have now many photographs [illegible] ready for treatment in the manner here [illegible] no hesitation in saying that the most prom[illegible] astronomical investigations in the present and in the immediate future will be that in connection with the [illegible], the result of which will be demonstration of the evolution of stellar systems in this manner from roaming clouds of nebulous or meteoric matter in the expanse of space.

NEBULA MESSIER 61 VIRGINIS.

R.A. 12h. 16m. 18s. Decl. 5° 1'·7 North. Epoch 1900.

Scale—one millimètre to twelve seconds of arc.

References.

N.G.C. 4303. G.C. 2878. *h* 1202. H I. 139. Rosse, *Obs. of Neb. and Cl. St.*, p. 113. *Phil. Trans.*, 1833, Pl. XV., Fig. 69, and 1861, Pl. XXVII., Fig. 21.

The photograph was taken with the 20-inch reflector on May 7th, 1899, between sidereal time 12h. 22m. and 14h. 25m., with an exposure of the plate during two hours and three minutes, and it shows the nebula to be a right-hand spiral viewed in a direction nearly perpendicular with its plane. It has a bright stellar nucleus, and several faint condensations in the convolutions, and two stars in the nebulous spaces between them; there are also two prominent tangential projections of nebulous matter on the *north following* side with a star at each termination, and they suggest the idea of projection by centrifugal force. Similar appearances are also seen on the photographs of the Great Spiral Nebula M. 51 Canum (published in *I.R. Photos. of Neb and Cl. of Stars*, Vol. II., Pl. XV.). There is also shown on the photograph hereto annexed a small faint spiral nebula with a stellar nucleus and three or four condensations in the nebulosity, thirty-two seconds *following* and 5'·9 north of M. 61, which is not recorded in the catalogues, and therefore may not have been observed before.

THE SECOND SERIES OF LINES IN THE SPECTRUM OF HYDROGEN.*

The presence of a second series of hydrogen lines, in addition to the ordinary series, in the spectrum of ζ Puppis, was announced in Circulars Nos. 12, 16, and 18. Accurate wave lengths could not then be determined for the less refrangible lines. Since then, measures have been made of six photographs of spectra of ζ Puppis, and two of spectra of δ Orionis. Following the notation proposed by Vogel for the ordinary series of hydrogen lines, the new series may be designated $H\alpha'$, $H\beta'$, $H\gamma'$, etc. A comparison of the wave lengths recently determined with two computed values, is given in the following table. The first of these is given in Circular No. 16, and is a slight modification of Balmer's formula. It is $3646.1 \frac{n^2}{n^2-16}$ in which n is an even number for the ordinary series of hydrogen lines, and an odd number for the additional series. The second formula is $\frac{1}{\lambda} = A + B\frac{1}{m^2} + C\frac{1}{m^4}$. This form was proposed by Kayser, immediately after the announcement of the

* Abridged from "Harvard College Observatory Circular," No. 55.

discovery of this series of lines. If we accept this formula, it would appear to be the true law connecting their wave lengths, and would render them comparable with those of other elements. The designation of the lines is given in the first column of the following table, and the wave lengths derived by Mr. King in the second column. The next two columns give the value of n, taken from the sixth column of the table in Circular No. 16, and the computed wave lengths taken from the seventh column of the same table. A similar comparison with the formula $\frac{1}{\lambda} = 27461 - 121790\frac{1}{m^2} - 352010\frac{1}{m^4}$, is contained in the last two columns of the table.

Des.	Obs.		Comp.	m.	Comp.
H_{α}'		5	10128.1	3	10435.2
H_{β}'	5413.6	7	5413.9	4	5413.0
H_{γ}'	4542.4	9	4543.6	5	4540.1
H_{δ}'	4200.7	11	4201.7	6	4200.6
H_{ϵ}'	4026.0	13	4027.4	7	4027.5
H_{ζ}'	3924.0	15	3925.2	8	3925.8
H_{η}'	3860.8	17	3859.8	9	3860.6
H_{θ}'	3815.7	19	3815.2	10	3815.4
H_{ι}'		21	3783.4	11	3782.1
	..	∞	3646.1	∞	3641.5

On the whole the observed values agree more nearly with the first formula than with the second. This is remarkable, if it does not represent the true law, since this formula contains no arbitrary constants. There is only one constant, and that is determined with great accuracy from the ordinary series of hydrogen lines. The second formula contains three arbitrary constants which are selected so as to represent the observed value as nearly as possible. A least square determination was not considered necessary, since the outstanding differences from observation were evidently systematic, and not accidental. The wave length of the line $H\alpha'$ differs greatly according to the two formulas, but no means as yet exist for determining radiations of such great wave length in the stars.

Cambridge, U.S. Edward C. Pickering.
February 11th, 1901.

[The interest attached to the "second series" of hydrogen lines arises from the fact that they were identified as probably belonging to hydrogen by a purely mathematical process.

It is a remarkable circumstance that we are so much indebted to a study of the celestial bodies for our knowledge of the spectrum of hydrogen. Even the ordinary series of lines in this spectrum was first recognised in its entirety in the photographic spectra of white stars, but unlike these, the new series has not yet been reproduced in terrestrial experiments. Carrying Prof. Pickering's inquiry a step further, Rydberg has concluded that there is still another series of hydrogen lines, of which the only one in the visible spectrum is about wave-length 4687.8; this also has not yet been artificially reproduced, but there is evidence that it is represented by an important line in the spectra of some of the Wolf-Rayet stars and planetary nebulæ.

The three series of lines of hydrogen thus differ from the corresponding series in the case of many other elements, inasmuch as they do not all appear simultaneously in the spectrum of the gas in laboratory experiments.—Ed.]

Letter.

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

LUNAR ATMOSPHERE AND OCEANS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—It has been considered (Proctor's "The Moon," pp. 263-265) that the theory that the hypothetical oceans and atmosphere formerly possessed by the moon have been withdrawn to internal cavities is untenable—though the existence of such cavities seems probable enough—since they could not be large enough to contain the volume of an atmosphere sufficient in quantity ever to possess any considerable density on the moon's surface. Also, it seems very improbable that the surface is at a sufficiently low temperature during the day to allow the atmosphere to remain always in a liquid or solid state on the surface. Now might we not combine these two theories with advantage? If all the moon's heat has been lost, any cavities in its structure must be at a temperature sufficiently low to reduce all gases entering them to the solid state; and these cavities, a few miles from the surface, will not be appreciably affected by solar heat. The cavities, which must be supposed to be in connection with the surface to some extent, would be full of air. When their temperature became sufficiently low, this air would liquefy, leaving an almost empty space. Into this space there would be a constant slight influx of gas throughout the day, the liquefaction, or, later, solidification of which would leave room for further quantities of air. If the temperature of the moon's mass has become equal to that of surrounding space throughout, may we not suppose that the whole, or very nearly the whole, of the atmosphere, as well as the oceans, may not be within the moon's mass, *in the solid state*, assuming, of course, that they have had an existence at all? The small quantities of heat introduced would be lost by conduction through the surrounding material, and could never, of course, stop the process.

J. O'May.

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

Red-faced Variety of the Yellow Hammer.—At the meeting of the British Ornithological Club, held on June 19th, Mr. H. E. Dresser exhibited an aberrant form of *Emberiza citrinella*, with chestnut-red colour on the throat like the Pine Bunting (*Emberiza leucocephala*). The specimen was obtained by Mr. E. S. Montagu in Cambridgeshire. Mr. Millais and Mr. Walter Rothschild also exhibited British examples of this aberrant form. In the course of some remarks in the *Ibis* (July, 1901, p. 453*), upon a similar specimen obtained at Yeniseisk, Mr. H. L. Popham writes that Mr Zarudny "considers that this variety points, to some extent, to atavism, and suggests an early ancestral form of *E. [illegible]*, nearly related to *E. leucocephala*." H. F. W.

Attempt to reintroduce the Great Bustard in Norfolk. Your readers are aware of the attempt recently made to re-introduce the Bastard into its old haunts on the borders of the counties of Norfolk and Suffolk, and that a number of these birds were sent from Spain to the care of Lord Walsingham, to whom the management of the interesting experiment was entrusted. Fifteen of these birds have survived the winter at Elveden, where they were placed on the estate of Lord Iveagh and allowed a run of some 800 acres of the same country which the indigenous race formerly frequented. All seemed going on well but, unfortunately, the birds, which had become very tame, left their secure retreat and seem to have spread over the country the result was, as it was too much to be feared, that two of them have been killed, and that by a gamekeeper at Finningham, who of all persons, the experiment having been largely advertised, should have aided in protecting them. Of course the naturalists of Norfolk were greatly disgusted at this unpardonable act, and immediately drew the attention of the Society for the Protection of Birds to the infraction of the Game Laws, and I understand that the man is to be proceeded against at the next meeting of the magistrates at Eye, Suffolk, for shooting game out of season. The punishment of the man, if convicted, will certainly be altogether inadequate, but the publicity thus gained may prevent others from repeating the offence, and to some extent protect the remaining thirteen birds which are at large should they not also have been killed, and their destroyers, warned by this example, have concealed the fact, which is too much to be feared.—T. Southwell, Norwich.

It is reported that Arthur Larkings, gamekeeper, Westhorpe, was convicted of the above offence at the Hartismere Petty Sessions, on July 8th, and fined the full penalty of one pound per bird, with £2 15s. costs, or in default one month's hard labour. W. H. Read, keeper to Lord Iveagh, remarked that of seventeen Great Bustards imported only seven remained. As Mr Southwell predicted, the penalty for Larkings' abominable deed is wholly inadequate, especially as the birds themselves cannot be confiscated. The law as it at present stands is altogether too weak to prevent these murderous acts. Is there no ornithologist in Norfolk of sufficient strength and courage to take the law into his own hands and administer a punishment to fit the crime?—H. F. W.]

Breeding of Wigeon in Ireland (*Irish Naturalist*, July, 1901, p. 147).—Mr. Robert Patterson has the satisfaction of being the first to record the breeding of the Wigeon in Ireland. The bird has been suspected of breeding there but the eggs have never before been found. Some ducks' eggs which Mr Patterson could not identify were sent to him by Mr. John Coffney, who found them near Belfast in May last. Mr Patterson accordingly visited the place on May 18, and found a nest with similar eggs, from which he flushed a Wigeon. Mr Ussher has compared the eggs and down, and "has no doubt whatever that they are Wigeon's."

White Wagtail at Bartragh, co. Mayo (*Irish Naturalist*, July, 1901, p. 146).—Mr. Robert Warren records that Mr Kirkwood has again, this year observed White Wagtails at Bartragh. Since this Wagtail has been seen during April and May in the years 1898, 1899, 1900, and 1901 at Bartragh [illegible] may be assumed that the west coast of Ireland forms [illegible] migratory routes to the north.

Migration of Birds [illegible] during the Autumn of 1900. By G. H. Caton Haigh (*Zoologist*, June, 1901, pp. 201-211).—Mr Haigh's annual [illegible] of great value to students of migration. Mr Haigh remarks that "the chief feature of the last autumn passage [illegible] complete total absence of visible migration [illegible] with in the district, but among the scarcer visitors [illegible] the Bittern, Red-necked Phalarope, Wood-sandpiper, [illegible] Little Auk." A number of birds of regular occurrence were conspicuous by their absence last autumn.

On the Winter Singing of the Song Thrush (Turdus musicus). By W. Warde Fowler, M.A. (*Zoologist*, June, 1901, pp. 212-218).—In a pleasantly written article founded upon personal observation Mr Fowler comes to the conclusion that the Song-Thrush sings in winter in still open weather when food is easy to get at. He is inclined to think that in the case of mature birds the winter song is a forecast of the coming breeding season, while the immature may very possibly use their voices only in what has been termed "voice-play."

Rose-coloured Pastor in Kent (*Zoologist*, June, 1901, p. 223).—Mr. L. A. Curtis Edwards records that an adult male of this irregular visitor to Great Britain was secured on May 14 in Romney Marsh.

Red-footed Falcon in Shropshire (*Zoologist*, June, 1901, p. 224).—Mr. H. E. Forrest writes that an immature female specimen of this Falcon, which is a summer visitor to Europe, and rarely reaches as far north-west as Great Britain, was shot near Shrewsbury on May 18.

All contributions to the column, either in the way of notes or photographs, should be forwarded to **Harry F. Witherby**, ***at 10, St. Germans' Place, Blackheath, Kent.***

Notices of Books.

"Morphology of Spermatophytes." By J. M. Coulter, Ph.D., and C. J. Chamberlain, Ph.D. (New York: D. Appleton & Co. This book presents in a practical and informing manner comprehensive information gleaned from numerous authorities together with original investigations and observations of the authors on the morphology of seed plants. The various chapters are devoted to the treatment of Cycadales, Ginkgoales, Coniferales, Gnetales and the Fossil Morphology, Phylogeny, and geographic distribution of gymnosperms. The provision of laboratories in regions where the plants are indigenous has enabled their peculiar characteristics to be studied in a thorough manner, and an increasing amount of attention has been and is being devoted to the subject. Numerous illustrations render the text clear, and the histological structure as revealed by the microscope is well displayed. The progressive nature of the investigations and the extent of the ground that is covered by the groups dealt with, precludes finality of knowledge and information, but the present work, which brings many new and interesting facts to light, has been prepared with great care and discrimination, and is written in a very lucid and interesting manner.

"The Norwegian North Polar Expedition, 1893-1896. Scientific Results." Vol. II. Edited by Fridtjof Nansen. (Longmans, Green & Co.) 30s. net. This second volume of scientific results shows even more clearly than the first that the Norwegian North Polar Expedition was not merely an attempt to reach the North Pole, but a well organized scientific expedition, prepared under the direction of a capable leader who was fully aware of the opportunities afforded by such an expedition.

The volume is divided into three Memoirs VI., VII., and VIII. dealing with the astronomical, magnetic, and pendulum observations, nearly all of which, with the exception of the observations from the sledge journey, were made by Captain Sigurd Scott-Hansen. These observations have been brought together and discussed with that thoroughness and detail that marks the whole expedition, ranking it easily first among recent expeditions of this nature.

Memoir VI., containing the astronomical observations, has been prepared by Prof. H. Geelmuyden, whilst Prof. H. H. Turner has also gone over the proofs of the introduction to this section. The astronomical equipment consisted of alt-azimuths, sextants, telescopes, together with chronometers and azimuth compasses. For the determination of latitude and local time a large alt-azimuth of 2-inch aperture was most frequently used, and the method by altitudes adopted. As will be readily seen, this method in high latitudes is subject to somewhat large errors, but remembering that the ship was not stationary, but

* See Knowledge, October, 1900, p. 230.

drifting irregularly with the ice, the elements of uncertainty are of the same magnitude throughout, a small drift giving a considerable difference in longitude and local time. For the rating of the chronometers for use with the half seconds pendulums, observations made by the above method were useless, and consequently observations of the solar eclipses of 1894, April 5, and 1895, March 25, as well as observations of lunar distances and eclipses of Jupiter's Satellites were employed for the determination of Greenwich time. During the famous sledge journey of Nansen and Johansen it happened once that the working day of the men had been longer than that of the watches, with the result that both watches ran down, and henceforth the determination of longitude on this journey became more difficult, for in addition to this the tables of lunar distances had (probably on account of portability) been cut out of the "Nautical Almanac," and although Nansen was continually on the look out for the moon during her period of visibility he was only able to make one observation, in consequence of the difficulty of picking up the moon by the naked eye on the pale sky, with the strong reflection from the immense white surface of ice. All the observations involving altitude were corrected by a refraction table with an extension of the temperature table down to −50° C., calculated by Bessel's formula, and observations were made on the sun and certain stars at temperatures ranging from −14·4° C. to −50·0° C., so that some idea of the accuracy of the prepared table can be made.

Memoir VII contains the magnetic observations made by Capt. Scott-Hansen during the voyage of the "Fram," as well as the few results it was possible to obtain on the sledge journey; it has been prepared by Prof. Aksel S. Steen of Christiania, and Prof. Ad. Schmidt of Gotha has increased the scientific interest of these results by calculating the theoretical values of the magnetic elements for all localities where magnetic observations were made. Dr. Schmidt's computed values are, however, for the epoch 1885, whilst the observations were made during the period 1893-1896. These observed results are tabulated, and the O—C's for declination, horizontal force, and inclination given in adjoining columns. The differences are in some cases large, e.g., the declination varies from −5° to +10°, but bearing in mind that they are for different epochs, and that they are uncorrected for diurnal variation, the observations show as close an agreement with theory as might reasonably be expected. Observations were made at 225 different places on 194 days, giving 70 declination, 99 horizontal intensity, and 80 dip results. The instrument by which the observations were made was specially designed by Dr. Neumayer for the conditions to be encountered, and was a combination of the Neumayer Declinatorium and the Fox Circle. As in all high latitudes magnetic storms were somewhat frequent, and during $1\frac{1}{2}$ hours on 24 November, 1894, the declination needle was perturbed through 26°. Captain Scott-Hansen does not, however, seem to have made any systematic observations for diurnal variation, but when it is remembered that the observations were frequently made with instruments mounted on an ice pillar and out in the open, ever liable to an attack from bears, the results are highly creditable. One reads that as a defence against bears a weapon, generally a revolver, was always at hand, though of course at a sufficient distance not to influence the readings.

Memoir VIII. deals with the pendulum observations, and has been prepared by Prof. O. E. Schiötz. The pendulums were of Col. von Sterneck's type, such as has been used by him on the Austrian Military Survey, i.e., half-seconds pendulum of invariable length. In a journey such as the "Fram's," opportunity did not exist for setting them up on the solid earth, and they were accordingly swung on the ship when drifting in the ice, and also on the ice itself. Such a proceeding would be highly satisfactory as being free from local influence due to mountains or high land, if it could be satisfactorily proved that the ice was rigid enough. The observations, however, are the first that have ever been taken at sea as it might be called, and show that there is nothing abnormal about the force of gravity over the polar basin, the result being g = 983·147 for mean latitude 85°, and, therefore Prof. Schiötz assumes that it is normal over all the great oceans. All the swings appear to have been made at the normal pressure; it would, perhaps, have been more interesting if they had been made at the usual pressure of 50 mm., and swung over 2 hours, but the chronometers could not be rated to the ideal accuracy, and the ice changes would, no doubt, have been greater. Capt. Scott-Hansen is to be commended on doing the right thing under the circumstances, and thus securing valuable results. The amount of work to show by so small a band as that on board the "Fram" fills one with admiration, and at least one could not have found time to suffer from ennui. Capt. Sigurd Scott-Hansen, whom Nansen deservedly praises for the excellent work done by him under difficult conditions, and brought together in the three Memoirs cited above.

"THE BIRDS OF SIBERIA." By Henry Seebohm, F.L.S., F.Z.S., F.R.G.S. (Murray.) Illustrated. 12s. net.—The late Mr. Seebohm's two delightful books "Siberia in Europe" and "Siberia in Asia," have long been so rare and difficult to obtain that this volume which is practically a reprint of these books of travel will be very welcome to those who are not the fortunate possessors of the original volumes. The first journey to the River Petchora was, we believe, planned and originated by Mr. J. A. Harvie-Brown, who was Mr. Seebohm's companion on the expedition. In the Petchora delta the grey plover, the little stint and Bewick's swan were found breeding, and well authenticated eggs were brought home. The eggs of Bewick's swan had never before been discovered, while those of the grey plover and little stint were almost unknown. In the second journey, accompanied by Captain Wiggins, Mr. Seebohm explored the great river Yenesei, from Krasnoyarsk to its mouth. The eggs of many little known birds were obtained, and a large and interesting collection of birds was made. At the time of the author's journeys (1875 and 1877) there was no railway east of Moscow, and enormous journeys by sledge in winter had to be undertaken. The book by no means deals exclusively with birds. The sledge and boat travelling are vividly described; there are many interesting observations on the natives of Siberia, and the breaking up of the ice on the great rivers is graphically depicted. The present volume has been only slightly edited, and several inaccuracies and repetitions have been allowed to remain. A few notes, comprising chiefly Mr. Popham's ornithological discoveries on the Yenesei, have been added to the text. We do not admire the cover, but the inside of the book is well printed, and two fascinating books of travel are now brought within easy reach of those interested in northern regions.

"THE ELEMENTS OF DARWINISM." By A. J. Ogilvy. (Jarrold & Sons.) 2s. 6d.—It is impossible for anyone who is not a naturalist by instinct and observation to appreciate to the fullest extent the structure upon which evolution depends for support, whether it be natural selection or acquired characteristics. A broad and general knowledge of the conditions and processes involved can be obtained by reading, and there are many people who are satisfied with such a view. Mr. Ogilvy gives a survey of Darwinism suitable for readers of this class. His book is a primer which can be understood by those who are unfamiliar with the technicalities of natural history, even though sometimes they may not see the real significance of the facts described. Every cultivated person ought to have grasped the simple statements and principles expounded in this little volume, because the knowledge would make them realise their responsibilities in the natural and social worlds. Of course, as the book only surveys Darwinism it is not a complete statement of the doctrine of evolution, and it may lead to the idea that the two terms are synonymous. But sufficient is said to show the reader that natural selection is not the only road to evolution, and interested students will follow up the subject in other books. Dr. Wallace looked through Mr. Ogilvy's book before publication, and the contents have his general approval, though the author alone is responsible for the treatment of the subject.

"ELEMENTARY PRACTICAL MATHEMATICS." By M. T. Ormsby. (E. & F. Spon.) 7s. 6d. net.—A great change is taking place in the methods of teaching mathematics. The old idea that only those parts of the subject of which a student knows the rigid proof should be used by him is becoming discredited. The opinion is gaining ground that it is advantageous to teach students, especially practical men engaged in engineering and the constructive arts, the application of mathematical results, leaving the formal steps by which such formulæ are arrived at to the professional mathematician. Just as in ordinary life it is not considered necessary for every person who carries a watch to understand its mechanism before telling the time of day, it is very reasonably argued that an engineer should know how, for example, to simplify his calculations by the use of logarithms, even though he may be ignorant of the proof of the Binomial Theorem. This view of the teaching of mathematics has recently received official sanction by the publication, in the "Directory" of the Board of Education, of a Practical Mathematics Syllabus. It is to meet the requirements of students such as those who present themselves for the South Kensington examination that Mr. Ormsby has written his book. He has included in it all those parts of arithmetic, algebra, trigonometry, geometry, and the calculus, which are frequently employed in the workshop, and while using great care to prevent the formation of misconceptions on the part of the reader, he has kept steadily in view those problems and theorems of constant use in everyday practice. Graphic work, especially the plotting of curves, [illegible] work. W[illegible] too much for the [illegible] them [illegible]. But the book [illegible] is an excellent work of [illegible] workshop.

Deschanel's Natural Philosophy. Part III. Electricity. Prof. J. D. Everett, M.A., D.C.L., F.R.S. (Blackie & Son.) 1901.—Deschanel's work has been a standard students' book for many years through the translation made by Prof. Everett. In this part, which is devoted to Electricity and Magnetism, the amount of progress to be reported has become so great as to necessitate almost a complete rewriting. Many of the old figures still remain, but the text is very much changed. Attention can be directed to a few of the novelties only. The modern ideas of electrical action are fully stated; accounts of practical terms are given, such as "angle of lead," "characteristic curves," and the like. The usual method of conveying electric power by polyphase currents, Ewing's magnetic tests of iron, descriptions of modern galvanometers, Hertz's experiments, Poynting's theorem on the propagation of electromagnetic energy—these references will sufficiently demonstrate that the book is up to date. Deschanel's treatise always occupied a special rank of its own. It was not simply a record of discovery more or less furnished with links of "theory"; in short it was scientific in spirit. We think in the present edition, Prof. Everett is to be congratulated on having maintained this position. The rigour of the work has not diminished; it has not been sacrificed to give a smattering of the things which are newest. It is a book for study. Used by students who are receiving at the same time a good practical laboratory course, it will be of great value in keeping the fact before them that a knowledge of electricity does not solely consist in being able to carry out certain measurements. The amount of work necessary to master the contents of the book is much more than its size would probably indicate. Occasionally the style seems difficult, but to the earnest student this will be an incentive to close study.

BOOKS RECEIVED.

Colloquies of Criticism. (Fisher Unwin.) 3s. 6d. net.

Two Undiscovered Planets. By G. E. Sutcliffe. (Bombay: Theosophical Book Depot.)

Poems. By W. B. Yeats. (Fisher Unwin.) 7s. 6d.

Matriculation Directory (The University Tutorial Series). June, 1901. (Cambridge: Burlington House.) 1s. net.

Sculptures of Santa Lucia Cozumahualpa, Guatemala, in the Ethnological Museum of Berlin. By Herman Strebel. (Smithsonian Institution.)

Poisonous Plants in Field and Garden. By the Rev. Prof. G. Henslow, M.A., F.L.S., F.G.S., &c. (Society for Promoting Christian Knowledge.) Illustrated. 2s. 6d.

Fifty Years of Catholic Life and Social Progress. Vols. I. and II. By Percy Fitzgerald, M.A., F.S.A. (Fisher Unwin.) 21s.

Microscope and its Revelations. By the late William B. Carpenter, C.B., M.D., LL.D., F.R.S. Revised by the Rev. W. H. Dallinger, D.Sc., D.C.L., LL.D., F.R.S., &c. (J. & A. Churchill.) Illustrated. 28s.

Life and Letters of Gilbert White. 2 Vols. By Rashleigh Holt-White. (Murray.) 32s.

Natural History and Antiquities of Selborne. By Gilbert White. Edited by L. C. Miall and W. Warde Fowler. (Methuen & Co.) 6s.

Retrospect of Surgery during the Past Century. By John Poland, F.R.C.S. (Smith Elder.) 5s.

Hypnotism and Suggestion in Therapeutics, Education and Reform. By R. Osgood Mason, A.M., M.D. (Kegan Paul.) 6s.

Journal of the Society of Comparative Legislation. June 1901. (Murray.) 5s.

Civilian War Hospital. By the Professional Staff, Portland Hospital. (Murray.) 12s. net.

Your Mesmeric Forces and How to Develop them. By Frank H. Randall. (Fowler.) 2s. 6d. net.

International Art Notes. March, 1901. (Swan Sonnenschein.) 6d. net.

Stalk-eyed Crustacea of British Guiana, West Indies, and Bermuda. By Charles G. Young, M.A., M.D. (Watkins.) 12s. 6d. net.

Amphibia and Reptiles. By Hans Gadow, M.A., F.R.S., &c. (Macmillan.) Illustrated. 17s. net.

Bulletins of the Philosophical Society of Washington.

Annual Reports of the Bureau of American Ethnology. Seventeenth (Part I.—1895-96). Eighteenth Part I. 1896-97).

Catalogue of Photo Apparatus. (City Sale and Exchange, 93 and 94, Fleet Street.)

NOTES.

Astronomical.—We note with regret that the two photographs of Nova Persei and surrounding stars, reproduced in the July number, were dated 1900 February 20, and 1900, February 28. In each case the year should, of course, have been 1901.

In Circular No. 50, Prof. Pickering gives a summary of the observations of Nova Persei made at Harvard up to May 3, 1901. The characteristics of the spectrum prior to March 19 are sufficiently well known to need no further reference here, and the subsequent observations may be regarded as confirmatory of those made at Stonyhurst, Kensington, and elsewhere. About March 19, the star became a variable with a period of from 2 to 5 days, and the general result of the Harvard photographs seems to be that there were well-marked variations of spectrum accompanying the changes of magnitude. On March 27, 30, April 1, 13, and 27, the spectrum was "normal," while on March 19, April 12, 26, 28, May 1, and 3, it was "peculiar"; among the chief peculiarities apparently being that a green band extending from 4990 to 5010 was greatly intensified, while H ζ was either displaced or replaced by a new line with its centre about λ 3875. The "peculiar" spectrum was associated with a minimum of the star except on April 12. No attempt is made to explain the origin of the peculiar lines, but it is not improbable that the green band, which was brighter at the minima, was the chief nebular line at λ 5007, while the band with its centre about λ 3875 was possibly identical with a line which is among the brightest in the spectrum of the Orion nebula and certain planetary nebulae.

A recent investigation of sun-spot data undertaken by Dr. W. J. Lockyer has led to the conclusion that underlying the recognised 11-yearly period there is another cycle of about 35 years' duration. This periodicity exhibits itself in the varying intervals between the minima and succeeding maxima, and in the total spotted area from one 11-yearly period to another. Corresponding variations have also been traced in the curves of the terrestrial magnetic elements. A 35-yearly period has been previously found by Brückner in climatic changes, and by Richter in the movements of glaciers, while Mr. Egerson has found a period of from 33 to 34 years in the occurrence of rainfall, thunderstorms, and westerly winds in the month of April at Sydney.

We learn from Mr. Maunder that he has been detained at Mauritius, and will not reach England until late in August. On his return, Mr. Maunder will publish in this journal a plate of the Sun's corona, of which successful photographs have been obtained.—A. F.

Botanical.—A paper on the longevity of seeds, based on the examination of numerous grains of wheat and barley discovered during recent investigations in Egypt, and dating back upwards of four thousand years, appeared in Vol. 130 of the *Comptes Rendus de l'Académie des Sciences, Paris.* The conclusions of the author, Monsieur Gain, are distinctly opposed to those of Alphonse de Candolle, who did not consider it impossible that a seed may preserve its vitality for four or five thousand years; and the testimony of Count Sternberg, who believed that he had actually procured the germination of two grains of mummy wheat, is dismissed as valueless. It is shown that in order for an old seed to germinate three conditions are necessary. First, the reserve material must remain chemically intact, and this is the case in many grains of mummy wheat and barley; second, the embryo must retain an organisation so that the enzyme required for the digestion of the reserve material may be produced; and third, if the preceding condition is realised, it would also be necessary that the embryo should remain in contact with the reserve material. In the seeds examined the embryo no longer existed in contact with the albumen, and though it retained its cellular organisation, each cell had undergone a chemical change indicating the death of the embryo at a remote period. The author concludes that grains of mummy wheat and barley, in spite of their external appearance of good preservation, do not possess a cellular organisation compatible with germination. S. A. S.

Entomological.—Some interesting researches under the direction of Dr. A. Weismann, and published by him in the *Anatom. Anzeiger* (Vol. XVIII., 1900, pp. 492-9), confirm the well-known view that the unfertilized eggs of the Honey-bee develop into drones, while the fertilized eggs always give rise to queens or workers. Considerable doubt has lately been thrown on this doctrine by practical bee-keepers, but the question seems altogether set at rest by Weismann's examination of over 300 eggs in the stage (that of the "second maturation spindle") when the sperm-aster, if present, can always be detected. In every one of the 62 eggs from worker-cells examined a sperm-aster was found; while only one of the 272 eggs from drone-cells contained a sperm-aster, and this was almost certainly due to a mistake on the part of the queen-bee, who is able to lay either fertilized or unfertilized eggs at will.

The development of the eggs and other cells in the ovary of the Queen-bee forms the subject of an exhaustive paper by W. Paulcke in the *Zoolog. Jahrb.* (*abth. f. anat.*), XIV., 1900, pp. 178-202, pls. 12, 12a, 13, 13a. In the thread-like ends of the ovarian tubes are numerous undifferentiated nuclei embedded in a common protoplasm. Further down the tubes some of these are seen to give rise to the cells of the follicular epithelium, while others form the eggs and the yolk-cells. The eggs and yolk-cells are formed by repeated division of the primitive germ-cells, forty-eight yolk-cells being produced for each egg, and the cluster of yolk-cells becomes separated from its neighbouring egg-cell by a follicular layer. The yolk-cells at first show marked growth and produce food-material which the egg absorbs by protruding a process into the yolk-follicle. Ultimately before the eggs enter the oviduct, the yolk-cells pass into the egg-follicle and become entirely engulfed by the egg-protoplasm. G. H. C.

Zoological.—By far the most important event we have to record in this column, so far as vertebrate zoology is concerned, is Professor E. Ray Lankester's exhibition before the Zoological Society of the skin and skull of the new mammal lately discovered by Sir Harry Johnston in the eastern borders of the Congo forest. The professor fully confirmed Sir Harry's opinion as to the intimate affinity existing between the okapi (as the new animal is called by the natives) and the extinct *Helladotherium* of the Tertiary deposits of Greece. It is believed, however, to be generically distinct, and the name *Okapia johnstoni* was accordingly suggested as its designation, the specific title having been previously proposed by Mr. Sclater, on the evidence of two pieces of skin sent home at an earlier date by Sir H. Johnston. The animal appears to be a comparatively short-necked, and short-legged representative of the giraffes; the general colour of the upper-parts being purplish-brown, with the thighs and upper part of the legs transversely striped in a somewhat zebra-like fashion. The skin, which has been mounted by Rowland Ward, Ltd., will probably be on exhibition at the Natural History Museum by the time these lines appear. For fuller details regarding this most interesting creature, we must await Prof. Lankester's promised memoir; but it may be observed that no such important discovery has taken place within the memory of the present generation. It is noteworthy that the Grecian deposits which yield *Helladotherium* also contain remains of giraffes.

In an article published in the June number of the *Geological Magazine*, Dr. C. J. Forsyth Major discusses the acquisition by the female of secondary sexual characters originally distinctive of the male. He shows, for example, that the females of the oxen were originally hornless; and that in those antelopes in which horns are present in both sexes they were originally restricted to the males, as is still the case in many genera of these ruminants. Of especial interest are the author's observations relating to the antlers of the deer, which, as is well known are, with the exception of the reindeer, normally restricted to the stags alone. It is pointed out that in one district of Russia reindeer hinds are reported to be still devoid of antlers; and evidence is adduced showing that in the roedeer the female is now tending to acquire antlers, those appendages being frequently developed in that sex at all ages.

Visitors to the palæontological galleries of the Natural History Museum cannot fail to be struck with the skeleton of a huge, half frog-like, half salamander-like extinct reptile from South Africa, labelled *Pariasaurus*. Hitherto these strange creatures have been regarded as exclusively African, but news now comes of their discovery in Russia. This is a fact of the highest importance to the students of the geographical distribution of animals.

We wish every success to the Fifth International Congress of Zoology, which is to be held in Berlin from the 12th to the 16th of August. A good programme has been arranged, and a large number of papers for reading have been promised. On August 17th Hamburg and its excellent Zoological Gardens and Museum will be visited by those who care, while on August 18 there will be an excursion to Heligoland.

Polar Exploration.—The present year promises to be a record one in the way of Antarctic and Arctic Expeditions, as whilst four sail to explore the former regions, no less than ten will be at work in the opposite parts of the globe, viz., (1) The Ziegler-Baldwin Expedition from America, attempting to reach the Pole; (2) the Russian Expedition, under Admiral Makaroff, on the famous ice-breaker "Ermak," built in England, exploring the regions between Spitzbergen and Novoya Semlja; (3) a Canadian Expedition under Capt. Bernier, of Quebec, sailing north from St. Johns with the object of reaching the Pole *via* Smith Sound; (4) a German Expedition from Hamburg with the same object by another route; (5) the "Capella" Expedition to Franz Joseph Land in search of the missing men of the Duke of the Abruzzi's Expedition; (6) the Peary Expedition in North Greenland; (7) the "Fram" Expedition under Capt. Johannesen, of Nansen Expedition fame, in the same regions; (8) Dr. Stein's Expedition in Ellesmere Land, returning this year; (9) Baron Toll's Expedition, which sailed last year in order to attempt to reach the Pole by Nansen's route, *via* the New Siberian Islands and the mysterious "Wrangel Land;" and, finally (10) the Swedish Expedition to Spitzbergen. The object of this last expedition is to measure the arc of the meridian, a work commenced there last year in conjunction with a Russian station in another part, the location of which will depend on the state of the ice. The expedition left Tromsö, in Norway, early in June, on board the well-known whaler "Antarctic," and returns in the autumn, when this vessel will carry the Nordenskjold Expedition to the South Polar Continent, and will thus in the same year have sailed both the Arctic and the Antarctic seas.

MEN AND MICROBES.

By E. Stenhouse, A.R.C.S., B.Sc.

The end of one century and the beginning of a new one seems an appropriate time for a stock-taking of progress—a time when we may usefully pause to estimate, to the best of our ability, the position in nature to which "civilisation" has brought us.

In such a mental survey at the present time nothing is more striking than our recognition of the fact that our daily lives are intimately bound up, for weal or woe, with the activities of countless hordes of tiny beings whose very existence was undreamt of a hundred years ago.

Bacteria or microbes are as ubiquitous as anything well can be. They occur in the water we drink, in the air we breathe, in the soil beneath our feet, and even in the interior of our own bodies. Were it not for the many services they continually perform for us, our life would be quite impossible; and, on the other hand, they have been proved to be responsible for the greater number of the infective diseases to which we are subject.

So minute are the possessors of these boundless powers for good and evil, that it is often necessary to magnify them some 800,000 times before they can be seen at all distinctly. To give some idea of this enormous magnification, it may be mentioned that an ordinary cigarette magnified in the same proportion would appear seventy yards long and about twenty-eight feet thick.

A bacterium of the cigarette-shape is known as a *bacillus*. The place of the tobacco of the cigarette is taken by a jelly-like substance called protoplasm; and the cigarette-paper is represented by an envelope which, however, covers in the protoplasm completely—at the ends as well as at the sides of the bacillus. Many bacilli possess threadlike outgrowths, by the lashing of which they are propelled through any liquid in which they may find themselves. Other forms, called *spirilla*, move by a serpentine twisting of their slender bodies; and yet other bacteria are globular in shape and are known as *cocci*. When a bacterium is full grown, it multiplies by breaking up into two or more pieces, each of which becomes a complete bacterium. As a bacillus becomes mature in half an hour, or less, one individual can thus give rise to about 17,000,000 in twenty-four hours. When the supply of food runs short or the surroundings become in other respects unfavourable, many bacteria form themselves into spores which possess very great powers of resistance. They remain in the resting stage until the hard times are over, and then with unimpaired vigour, resume their ordinary mode of life.

Of the many useful services which bacteria perform perhaps the most conspicuous is that of breaking up refuse animal and vegetable matter into harmless and often useful substances. That the putrefaction of organic matter is really due to minute and air-borne forms of life was proved conclusively by Pasteur and Tyndall about the middle of the nineteenth century. It was shown that if well-boiled broth is kept in vessels from which the air is either wholly excluded or so admitted that all floating particles are arrested, no putrefaction occurs and the broth remains sweet for an indefinite time.

The importance of bacteriological research is persistently forcing itself upon the attention of municipal authorities, not only because it shows how disease-epidemics may be best prevented and stamped out, but also because it indicates solutions of such important problems of public health as the disposal of sewage. Various modifications of the biological treatment of sewage are already at work in this country, and are giving very encouraging results. Essentially, the process consists in passing the sewage—which may previously have been partially purified by allowing the grosser particles to settle in tanks—through filter-beds of clinker or broken coke. A scum soon forms on the coke, and microscopic examination shows that the scum swarms with myriads of bacteria. The bacteria break up the foul organic matter into harmless substances. The efficacy of their work may be judged by the fact that of several effluents I have recently analysed, the putrescent organic matter had on the average been reduced to less than one-seventh as the liquid was trickling through the coke.

It has been found that bacteria play a most important part in enriching the soil with nitrates, a very necessary food of plants. Generally the raw material consists of the simpler compounds of nitrogen—those of ammonia, for example; but the roots of leguminous plants contain bacteria with the very remarkable power of taking nitrogen directly from the air and putting it at the disposal of the plant.

The propriety of including yeast-cells with bacteria is perhaps, questionable; but the indirect influence upon frail humanity of these minute manufacturers of alcohol is so great that they can scarcely be ignored here. It is becoming widely recognised that several species of yeasts exist, and that success in brewing depends largely upon the rigorous exclusion of the "wild" varieties.

The careful work of the brewer may be brought to naught in a few hours by the activities of another microbe, should it gain access to the finished beverage. The vinegar-organism, as it is called, attacks the alcohol and changes it into acetic acid. Neither beer nor wine ever "goes sour" of itself, if the little plant is absent. Similarly, milk is turned sour by the lactic acid bacillus. Still others give their characteristic flavours to butter and cheese; and it has even been asserted that many of the changes which tobacco undergoes in curing and mellowing are due to the action of bacteria. Certain workers are at present investigating the important point, with the object of breeding pure cultures of the races to which a good cigar may owe its peculiarly seductive aroma.

These are a few only of the almost numberless cases in which we are indebted not only for our luxuries but for the very means of life itself, to the silent but ceaseless labours of these tiny organisms. Moreover, if there is anything whatever in the theory of modification by descent, we ought to be able—considering their fabulous rate of multiplication—to bring about in a comparatively short time changes in the structure and habits of some of our "tame" bacteria which will make them minister to our health and comfort to a degree hitherto undreamt of.

Whilst, however, we freely admit our great indebtedness to bacteria, we must not forget that their powers for evil are also enormous.

In 1849, Pollender discovered minute rod-like bodies, one four-thousandth of an inch long, in the blood of animals which had died of anthrax or splenic fever, and he suggested that these tiny rods bore some definite relation to the disease.* Fourteen years later Davaine announced that the rods were living plants, and that blood containing them had the power of passing on the disease to another animal inoculated with it; while blood from which the bacilli were absent had no power of conferring the disease. About 1876 Koch discovered how to grow the organism outside the body; and Pasteur subsequently found that by keeping artificial cultures of the anthrax bacillus at a temperature slightly above that of the blood the organisms gradually lost their deadly power, and after 43 days had no injurious effects upon even the most susceptible animals. After being inoculated with such harmless cultures, the animals were subjected to the action of cultures of gradually increasing strength, until after a short time it was found that they could easily withstand a dose which would at first have proved immediately fatal. The animals had, in fact, become protected against the disease. This brilliant discovery has already been put to very extensive use, and the method of inoculation is now recognised as a certain means of protecting horses, sheep, cattle, and even elephants against the ravages of splenic fever.

The activities of the anthrax bacillus may be regarded as illustrating the ways of malignant bacteria generally. There is, however, considerable variation in minor details of structure and mode of life. For example, while the rod-shape or bacillus is the form of the organisms responsible for anthrax, typhoid, diphtheria, "consumption," and some other diseases, the microbes giving rise to erysipelas are not bacilli, but minute globular bodies (cocci) which stick together in rows, like beads; and the cause of cholera is a tiny comma-shaped bacterium. While, again, some microbes gain access to the blood, and thus by their marvellous powers of multiplication spread throughout the whole body, others remain at the point of inoculation, and yet set up profound disturbances in the system generally which ultimately end in death.

The last-mentioned fact, that the organisms themselves may be restricted to one point, while their evil effects may extend throughout the body, suggests that during their life they give off poisonous substances to which, rather than to the bacteria themselves, the diseases are due. This has repeatedly been proved to be the case. Here, again, anthrax furnishes an instructive example. It has been found possible to prepare from artificial cultures of the anthrax bacillus an intensely poisonous substance, which is nevertheless free from the bacteria; and this poison or *toxin* of anthrax induces, if injected into the blood of an animal, all the characteristic symptoms of the disease. Nor is this all. The strength of the toxin can be so regulated that while it is insufficient to cause death, it protects the animal against future attacks.

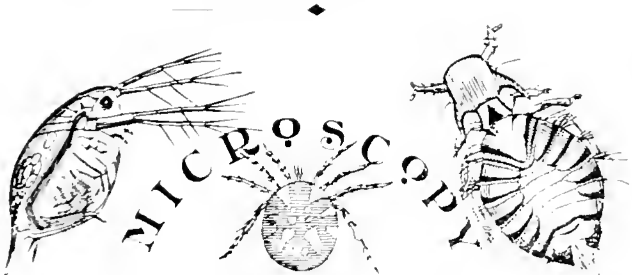
The theory which at present best explains these remarkable facts is that the toxins stimulate certain cells of the body to manufacture substances which neutralise them. These toxin-destroying substances are called *antitoxins*. Once the cells have got into the habit, so to speak, of producing antitoxins, they continue the work, and lay in a stock which is sufficient to promptly render useless the poison-armoury of the particular race of bacteria, should these again invade the territory.

The fact that the terrible zymotic diseases are due to blood-poisoning by toxins, and the possibility that for every toxin there is a corresponding antitoxin—in other words, that every disease produces its own antidote—which may yet be discovered and isolated, are sufficient to explain the tireless enthusiasm with which bacteriologists have of late years carried on their researches. Marked success has in many cases attended their efforts, and the manufacture of certain antitoxins is now carried on upon a somewhat large scale. The antitoxin of diphtheria, for example, is regularly prepared by a large German firm, and sent out to all parts of the world. The bacilli of the disease are first grown in specially prepared broth for about a month, by which time the fluid has become strongly impregnated with the poisonous toxin. The bacteria are filtered off, the clear solution obtained containing the toxin. This is then injected into horses in gradually increasing doses, until the animals can withstand a large quantity without inconvenience. Then after a few days' rest they are bled from the jugular vein. The whole operation is so carried out that the horses suffer practically no pain whatever, and very little injury to their general health. The blood is allowed to clot, and the clear fluid (serum) which rises to the top contains the antitoxin, and is hence known as anti-diphtheritic serum. It is now injected, in doses varying with the severity of the disease, into patients suffering from diphtheria. As a result of the treatment the mortality from this disease has been greatly lessened. Antitoxins have also been prepared for protection against and treatment of various other diseases, including typhoid, tetanus (lockjaw), plague, hydrophobia, and snake-poisoning. A few years ago there seemed to be grounds for believing that a cure for consumption had been discovered. The anticipations were, unfortunately, not realised; but the extract of "tuberculin," which it was hoped would rid humanity of its greatest scourge, forms a means of identifying tuberculous cows, and thus of removing one source of the disease.

The indictment against these low forms of life is a terrible one. Disease and dirt are, however, closely connected, and the introduction of better sanitary conditions will of necessity exterminate many diseases. As a rule, only those in a low state of health need fear these minute foes, for they are in nearly every case unsuccessful against vigorous constitutions. The various fluids of the healthy body have a distinctly injurious effect upon malignant bacteria, and it has recently been found that there are in our bodies certain wandering cells which in health act as policemen, promptly seizing and devouring the harmful microbes which do gain access to the system. The tonsils, for example, are crowded with these guardian cells.

The fact that during the progress of a disease the blood acquires properties inimical to the growth of the bacteria is very marked in the case of typhoid, and affords a means of diagnosing the disease. If we examine microscopically a drop of broth containing a young culture of the typhoid bacillus, we see the deadly plants darting and wriggling about the field in all directions. On diluting the drop with healthy blood-serum, no loss of activity is to be seen, but if the added serum is that of a patient suffering from typhoid, the movements slow down, and the bacilli seem as if paralysed. They collect in separate clumps, strongly suggesting different swarms of midges, and in a minute or two all is over. The bacteria are dead. The sight is, in its way, as striking as anything I have seen. It irresistibly brings up before the imagination the fierce struggle which goes on when disease-germs invade the body. Should they escape arrest by the "policeman-cells," they begin their deadly work, but all the reserve forces of the invaded country are called out. The intruders have first to fight against the healthy fluids of the body. If these are unsuccessful the bacteria live and multiply and give off their poisons. Immediately, however, the body responds and brings forward a supply of antitoxins. Then it is war to the knife. If the bacteria can produce toxins faster than the body can supply antitoxins, they win, and the patient sinks. The only hope is that, before general collapse has gone too far, a timely injection of the required antitoxin may put the enemy to rout.

The possibility of the last resource is due to the labours of such men as Pasteur, Lister, Koch, and their followers. They have shown that we have to fight for our lives against enemies, unimaginably small, but present everywhere and in countless myriads; but they have also been able to classify the foes into races and nations, to discover their various methods of attack, and in many cases to forge weapons by which these attacks may be foiled. The work is only in its infancy, but there is every reason to believe that its ultimate achievements will do more for the well-being of mankind than any other nineteenth-century discovery.



Conducted by M. I. Cross.

Microscopic Vision.—A paper of unusual interest entitled "An examination of the Abbe Diffraction Theory of the Microscope," was submitted for the consideration of the Royal Microscopical Society by Mr. J. W. Gordon, at the meeting held on June 19th last. It was sought to demonstrate that many of the experiments on which the Abbe theory is based were fallacious and incorrectly interpreted, and new ideas concerning the formation of the microscopic image were given.

It would be impossible, in the space at my disposal, to give even a brief *résumé* of the paper, for it will occupy probably fifty pages of the Society's journal, added to which I have not an advance copy of it before me, and only had an opportunity of examining it for a short time during the few days it was at my disposal. To do it justice, it will require to be read with consideration, and the experiments described actually worked out.

A paper of this description is of immense value, because it brings prominently before present day microscopists straightforward statements which each can for himself verify or disprove, and, by comparing them with Abbe's experiments, gain considerable information on this interesting subject. The matter will surely give rise to discussion, and it is to be hoped that a tangible result may follow.

So far as the Abbe theory is concerned, it has to be borne in mind that Abbe's original papers were written more especially for those who had the benefit of a German University training in physics, and the actual experiments which Mr. Gordon in his paper seeks to disprove in some degree were intended, not as a complete proof of his theory, but as ocular demonstrations of some of his statements such as would appeal to those who had not had such training.

It has to be remembered further that the whole of Abbe's experiments are based on the assumption that the light used is parallel from a distant source, and directly the illuminant is brought near, as is the case in ordinary microscopical work where a lamp or a sub-stage condenser is used in focus, the whole circumstances are changed and the experiments cease to convince.

The publication of the paper will be awaited with interest, for it has awakened a doubt in some minds as to whether the microscopical image that is really utilized is influenced more by effects behind the objective produced by its aperture, than by diffraction effects in the object under examination. Under modern conditions of working where a condenser yielding a large aplanatic cone is used the condition of a self luminous object is practically realised, for in such a case each point of the flame reaches one conjugate point in the flame image, and if that flame image is brought into correspondence with the object, each part of the lamp flame lights one point of the object. All the points are separately illuminated and are therefore not capable of interference in a very marked degree (although as a matter of fact there is slight interference), hence the value of our modern wide aplanatic cones of illumination.

Preserving and Mounting Mosquitoes.—Some time has elapsed since the connection between mosquitoes and malarial fever was established, yet satisfactory specimens of the former have reached England in very small numbers although medical men and others who are interested in the matter have constantly wished to obtain them.

The reasons are that the unmounted specimens are not put up in suitable preservative medium for travelling, or if they are mounted, sufficient care has not been exercised in the process. Several methods have been published in medical papers on the subject of preserving mosquitoes, but none of them are really satisfactory ones. The following will be found to answer the purpose:—

To send unmounted mosquitoes by post they should be preserved in dilute alcohol, two parts of rectified spirit to one part of water. Too many should not be put into one bottle or they become entangled and broken.

To make permanent mounts, dilute glycerine, say one part glycerine to two parts water, in a shallow cell will be found best. The following is the process:—

1. Remove the dilute alcohol and soak in water until all trace of the spirit is removed.
2. Soak in dilute glycerine for about twelve hours.
3. Make cell, and when dry fill up with dilute glycerine and carefully place the specimens in it and apply the cover glass. Should the mosquito be too opaque after soaking in water, place it in a strong solution of carbolic acid for a few hours, and when transparent wash in water, then place in dilute glycerine.

Portable Microscopes.—At this season of the year when so many microscopists are travelling in search of health and pleasure, attention may be directed to a note on this subject in the April number of the *Journal of the Quekett Microscopical Club*.

It has often been remarked that effects can be obtained with large microscopes which cannot be secured with those of smaller size, and the home worker usually chooses a model of such large proportions as to render it unfit and inconvenient for carrying on short trips and holidays.

The provision of a convenient microscope of small size but yet of a thoroughly serviceable character becomes very desirable.

and hours during holiday time which might otherwise be dull and wearisome, could be rendered profitable and enjoyable if a microscope were available.

The special microscopes to which attention is directed are:—The Diagnostic Microscope by C. Baker, made at the suggestion of Surgeon-Major Ronald Ross, for the diagnosis of malarial fever, etc.

The American Portable Microscope by Bausch & Lomb, of Rochester, New York, the London agents for whom are Messrs. Staley & Co., Aldermanbury.

The Portable Continental and the Portable Star Microscopes by R. & J. Beck.

The Improved Clinical Microscopes by Swift & Son.

The Portable Microscope by Watson & Sons.

The above is practically a complete list of the portable microscopes that are made, excepting only a new one by Leitz. All of them have their points of advantage, either in weight, size, completeness of mechanical fittings, or price. The makers' catalogues will give full particulars.

In passing I feel bound to give special mention to the very neat and ingeniously made instrument by Swift & Son, referred to in the above list. It exactly fits my idea of a portable microscope.

Note on Examination of Blood.—A microscopical examination of a stained specimen of pathological blood implies a comparison with the appearance of normal blood when subjected to the same staining process. The experienced observer unconsciously makes use of his mental picture of the normal specimen in doing this work, and to him it is sufficient. In fixing and staining blood-spreads, however, a slight variation in technique may produce a decided difference in results, consequently those who have had comparatively little experience in such work will find it difficult to secure uniform results without a considerable laboratory equipment. In preparing pathological specimens in such cases a spread of normal blood may, at the same time, be subjected to the same technique and mounted on the slide with the pathological specimen, making exact and reliable comparison a very easy matter. Dried blood-spreads can be kept indefinitely, so a supply of normal specimens can easily be held in constant readiness for use.

NOTES AND QUERIES.

E. A. Jones.—I am sorry I cannot direct you to a source for Paleolithic flint implements, but if you were to communicate with Mr. T. Russell, of 78, Newgate Street, he would no doubt be able to put you in the way of obtaining them.

W. P. Williams.—A microscope suitable for general purposes and for the study of rocks and minerals need not be of special construction. It should have a stage that rotates concentrically, and this ought to be provided with screws so that it could be centred to any objective, or alternatively, a nosepiece with centering screws to attach to the lower end of the microscope tube and receive the objectives. You would need a polariscope; the polariser should have its rotating circle divided and a condenser system attachable over the prism to come flush with the surface of the stage. If you already have a substage condenser of large aperture, the polariser could be arranged to work with that. The analyzer would probably be found most useful if mounted over the eyepiece, and this also could have a divided circle attached to it. Extra fittings for petrology, such as a calcspar plate, Bertrand's lens, etc., would be applicable to an ordinary microscope equipped as above. If I can aid you further I shall be glad to do so.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. Cross, Knowledge *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. Denning, f.r.a.s.

Naked-eye Comets.—These objects certainly appear more often than is generally supposed, but the circumstances are unfavourable and the apparitions brief. A conspicuous comet is rarely presented under the best conditions, but when these occur, the spectacle is long remembered as one of special interest. Among those comets which were well exhibited from an observational point of view may be instanced Donati's 1858, Coggia's 1874, Tebbutt's 1881, &c. Certain other fine comets were seen by few persons, and have now almost entirely passed out of memory owing to the difficulties which attended their observation. On an average, a comet is visible to the naked eye annually, for since the beginning of 1880 more than 20 of these objects have been recorded, the list being as follows:—

Year.	Month.	Comet.
1880	February	Great southern comet, tail 40°.
1880	October ...	Hartwig.
1881	June-September	Tebbutt, fine comet, tail 45°.
1881	July-August ...	Schaeberle, tail 10°.
1882	May-June	Wells.
1882-3	October-February	Great comet, tail 22°.
1883-4	November-January	Pons (1812).
1886	April	Fabry.
1886	May	Barnard.
1886	November-December	Barnard.
1887	January	Great southern comet, tail 35°.
1888	April-May	Sawerthal.
1889	July	Davidson.
1892	April-May ..	Swift, tail 20°.
1892	November	Holmes.
1893	July .	Quenissett.
1893	October .	Brooks.
1894	April-May	Gale.
1895	November-December	Perrine.
1899	March-May..	Swift.
1901	April-May	Great southern comet, tail 15°.

The table might be increased by the addition of several other comets which were just visible to the naked eye, but in the historical records of these bodies details are not always given on this point.

The Great Southern Comet.—This object has now passed beyond the reach of the most powerful telescopes. There seems, however, a possibility that it may be re-detected in the early autumn, though the prospect is not an inviting one, the comet being situated at a considerable distance from the earth.

Comet Gale (1894, II).—Definitive elements have been computed by Mr H. A. Peck, from more than 500 observations extending over the interval of 141 days, from April 2 to August 21. The orbit proves to be elliptical with a period of 1143 years. The elements agree very well with those derived by the Rev. Dr. Roseby, from observations during 78 days which indicated a period of 1001 years.

Encke's Comet. This interesting object returns to perihelion in September, 1901, but the conditions will not be favourable, and the comet is not likely to be much observed. At the time of its passage through perihelion it will be on the opposite side of the sun to the earth. This comet was first discovered by Méchain, at Paris, in 1786, and at later returns by Miss Caroline Herschel, in 1795, by Thulis, in 1805, and by Pons, in 1818. Encke soon afterwards determined its real orbit and predicted its return in 1822, which duly occurred. Since 1822 the comet has made 21 returns, each of which has been observed.

August Meteors.—The moon will interfere with observation early in the month, but meteors are usually so numerous at this epoch that the observer may gather plenty of materials even in a bright sky. At the time of the maximum (August 11), and during the later stages of the shower, the circumstances will be more favourable, and with fine weather the display may be well observed. The paths of all the brighter meteors seen should be recorded, and especially those which belong to the minor streams. In every case it is desirable that the *direction of flight* should be noted with the utmost care and precision, for it is entirely upon this feature that the accuracy of the radiant point depends. The visible duration of the Perseid shower probably extends to the end of the third week in August, but it is extremely difficult to assign the definite limits. In 1900, the writer at Bristol saw a radiant of swift, streak-leaving meteors on August 22 at 59° + 59°, which corresponds with the probable place of the Perseid radiant on that date, but there is a persistent shower of Camelopardids from the same apparent position during August, and it is therefore doubtful whether the meteors annually seen on about August 21 and 22 are really late members of the great Perseid display. Observations should be made between August 17 and 22 with a view to obtain more evidence on the point.

Bright Meteor.—On July 8 a meteor, moving very slowly and with an extremely long path, was observed at Torquay by Miss L. M. Milner, and at Eastbourne by Mr. H. M. Whitley. At Torquay the object passed from α β Capricorni to Aries, while at Eastbourne the observed course was from μ Serpentis to Cor Caroli. The radiant was at 253° − 21°, so that it belonged to the June-July Scorpiids. At Eastbourne the meteor was as bright as Jupiter, and its duration was 10 seconds. It fell from heights of 53 to 26 miles, and its velocity was [illegible] 12th [illegible] Cassiopeia [illegible] meteors [illegible] W[illegible] and directing its flight [illegible] N.N.E. [illegible] The shower [illegible] quite a tenuous [illegible] writer [illegible] N. [illegible]

THE FACE OF THE SKY FOR AUGUST.

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

The Sun.—On the 1st the sun rises at 4.25, and sets at 7.47; on the 31st he rises at 5.1[illegible], and sets at 6.47. The disc should be carefully watched for spots.

The Moon.—The moon will enter last quarter on the 7th at 8.2 A.M., will be new on the 14th at 8.28 A.M., will enter first quarter on the 22nd at 7.52 A.M., and will be full on the 29th at 8.21 P.M. The following are the occultations visible at Greenwich 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.
Aug. [illegible]	D.M. [illegible]	6	12 58 A.M.	45	78	2 8 A.M.	266	261	18 4
" 5	ε Piscium	4.6	2 39 A.M.	84	99	3 47 A.M.	224	225	20 5
" 6	29 Arietis	6.5	10 51 P.M.	57	95	11 42 P.M.	269	309	22 1
" 7	D.M. +17°564	6.5	11 11 P.M.	26	62	11 45 P.M.	308	347	23 1
" 24	B.A.C. 6098	6.5	8 47 P.M.	44	5	9.51 P.M.	300	280	10 13
" 29	[illegible] Capricorni	5.2	12 54 A.M.	85	68	1 59 A.M.	221	199	14 17
" 30	κ Aquarii	5.5	12 29 A.M.	28	23	1 20 A.M.	278	262	16 16

The Planets.—Mercury is a morning star throughout the greater part of the month, being at greatest westerly elongation of 19° 23′ on the 2nd, and in superior conjunction on the 27th.

Venus is an evening star, setting about an hour later than the sun throughout the month, and therefore not conveniently situated for naked-eye observation. On the 15th the illuminated part of the disc is 0.873, and the apparent diameter 11″.8.

Mars is still an evening star, setting about 9.42 P.M. on the 1st, and about 8.15 P.M. on the 31st. The path of the planet is from near γ Virginis to near the eastern boundary of Virgo, passing a little north of Spica on the 18th. The apparent diameter diminishes from 5″.4 to 5″.0 during the month.

Jupiter will remain a very conspicuous object in the evening sky in spite of his low altitude. He is on the meridian at 9.40 P.M. on the 1st, and at 7.37 P.M. on the 31st, the apparent polar diameter diminishing from 42″.2 to 39″.0. The path is westerly, through Sagittarius, until the 30th, when it will be stationary. The more interesting satellite phenomena at convenient times are as follows:—

			H. M.				H. M.
1st	I.	Tr. E.	8 13	15th	I.	Sh. I.	10 30
	I.	Sh. I.	8 58		III.	Sh. I.	11 19
5th.—	II.	Sh. I.	9 15		I.	Tr. I.	11 48
	II.	Tr. I.	10 24	16th	I.	Ec. R.	10 5.5
7th.—	I.	Oc. D.	10 35	17th.—	I.	Sh. E.	7 17
8th	I.	Tr. I.	7 43		IV.	Tr. E.	8 32
	I.	Sh. I.	8 57	23rd	I.	Oc. D.	8 39
	I.	Tr. E.	10 0		I.	Ec. R.	12 0.1
	III.	Sh. E.	10 29	24th.	I.	Tr. E.	8 5
	I.	Sh. E.	10 53		I.	Sh. E.	9 12
9th.—	I.	Ec. R.	8 10.6	26th.	III.	Ec. R.	8 38.4
	IV.	Ec. R.	9 12.1	28th	II.	Oc. D.	8 59
12th.	II.	Tr. I.	9 56	30th.	II.	Sh. I.	9 9
	II.	Sh. I.	11 50		I.	Oc. D.	10 23
14th.—	II.	Ec. R.	8 52.5	31st	I.	Tr. I.	7 39
15th.—	III.	Tr. I.	7 21		I.	Sh. I.	8 50
	I.	Tr. I.	9 31		I.	Tr. E.	9 56
	III.	Tr. E.	10 26		I.	Sh. E.	11 8

Saturn [illegible] also [illegible] a little to the east of Jupiter. He crosses the meridian on the 1st at 10.9 P.M. and on the 31st at 8.6 [illegible]. On the 15th the apparent diameter of the planet will be [illegible], and the major and minor axes of the outer ring respectively [illegible] 11″.7 and 17″.9. The northern side of the ring is presented towards the earth.

Uranus remains in the most southerly part of Ophiuchus, nearly midway between Antares and ξ Ophiuchi. The planet crosses the meridian on the 1st at 8.8 P.M., and on the 31st at 6.9 P.M.

Neptune cannot be observed on account of his apparent proximity to the sun.

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 and Sagittarius in the south; Hercules and Ophiuchus towards the south-west; Corona and Bootes in the west; and Ursa Major in the north-west.

Minima of Algol will occur on the 9th at 9.4 P.M., and on the 29th at 10.47 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 July Problems.

No. 1.

(A. H. Williams.)

1. B to B8, and mates next move.

No. 2.

(B. G. Laws.)

Key-move.—1. Kt to K8.

If 1.	. K × R.	2. Q to Kt3, etc.
1.	. B × R.	2. Q to R6, etc.
1.	. P moves, etc.	2. Kt to B6ch, etc.

The above was the composer's intention, but the problem admits of three other solutions, by 1. R to K7, 1. R to Q4ch, and 1. Q to R6.

Six points have been scored this month by W. Nash, W. H. S. M., J. Baddeley, S. G. Luckcock, G. Groom, J. T. Blakemore, W. Jay, G. W. Middleton, W. de P. Crousaz, F. Dennis, G. W., V. H. Macmeikan, C. Johnston, A. C. Challenger, J. E. Broadbent.

Five points by H. Le Jeune, G. A. Forde (Capt.), H. S. Brandreth, Eugene Henry, H. Boyes, C. E. P., C. C. Massey.

Four points by Alpha.

Two points by A. E. Whitehouse.

C. C. Massey.—I cannot follow your reasoning as to Mr. Anderson's problem. As to 1. P × B (becoming a Queen), P to R8 (becoming a Knight), it is just because the Black Knight is unable to move that stalemate will result; supposing, that is, that White makes any attempt to mate.

Alpha.—1. B to K7 is answered by 1. . . . Q to QBsq.

G. W. Middleton.—Two keys score full points, whether the composer's intention be discovered or not.

H. Wood.—The conditions of your 8 Pawns problem are given below.

N. M. Gibbins. Many thanks for the problem: it is marked for publication in the autumn. There was no need for the re-introduction: I remember your former problem and have seen others of your composition.

British Chess Company. Regret that it is impossible to arrange a correspondence match on the lines suggested.

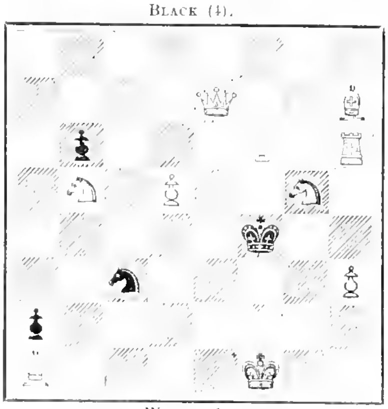
Mr. H. Wood, of Bolton, sends the following curiosity. Black is to have all his pieces and Pawns arranged in their proper order, as at the commencement of a game. White is to have a King and Pawns only, the former to be on his own square and the Pawns to be placed where he likes. How many White Pawns will be required, and where must they be placed, so that Black, even with the move, is mated in five moves or less? Correct solutions will be acknowledged, but the puzzle will of course not count in the solution tourney.

PROBLEMS.

No. 1.

By W. S. Branch.

Black (4).



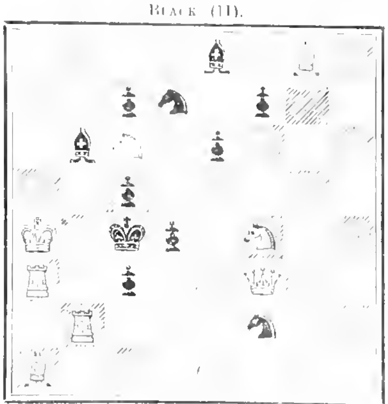
White (10).

White mates in two moves.

No. 2.

By W. Clugston (Belfast).

Black (11).



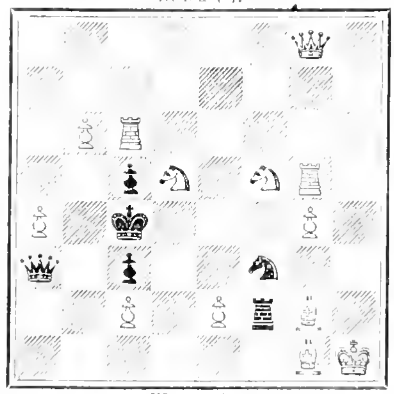
White (8).

White mates in two moves.

No. 3.

By W. H. Gundry (Exeter).

Black (6).



White (13).

White mates in two moves.

CHESS INTELLIGENCE.

Three counties are left in for the deciding round of the Southern Championship, viz., Essex, Surrey and Gloucester. In playing off the ties Essex have defeated Surrey, as stated last month, but lost to Gloucestershire by $9\frac{1}{2}$ to $6\frac{1}{2}$. Should Gloucestershire succeed in defeating or even drawing with Surrey, they will of course win the championship; but should Surrey win the match, the county which has scored most won games in its two deciding matches, drawn games being left out of the question, will be declared the winner.

We have to record, as a very unusual event, that the Scottish championship has not been won by Mr. D. Y. Mills. In the tournament of the Scottish Association, he tied for first place with Dr. Macdonald, both players scoring 6 games out of 7. In playing off the tie, it was agreed that one game only should be played; Mr. Mills was a Pawn ahead in the end game, but made a blunder which lost a piece and the match.

The principal event of the Kent Chess Congress, held at Folkestone during the Whitsuntide holidays, was an open tournament for first-class amateurs. The players were divided into two sections, Mr. Atkins winning in Section A, Mr. Serrailier being second, and Mr. J. H. Blake in B, after a tie with Mr. Tattersall. In playing off, Messrs. Atkins and Blake drew their game and divided the prizes. Messrs. Mortimer, Wainwright and Lowe were among the competitors.

KNOWLEDGE
AN
ILLUSTRATED MAGAZINE
OF
SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

Vol. XXIV.] *LONDON: SEPTEMBER, 1901.* No. 191

CONTENTS.

ON THE CAPRICIOUS HEARING OF CERTAIN SOUNDS AT LONG RANGE.

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

The last has hardly yet been said as to the vagaries of sounds of long range. Dr. Davison has contributed to Knowledge* a graphic record showing how at a great many distant places the minute guns fired at Spithead on February 1st were distinctly audible; some of these places, mainly lying to the N., being upward of a hundred miles away, while at the same time the sound waves in the immediate neighbourhood of Spithead were almost or quite imperceptible. Commenting on this, Dr. Davison conceives that the sound waves were first of all reflected by contrary winds over the heads of observers, but were afterwards brought down again by favourable upper currents. The same authority states that the report of guns, distant or otherwise, when inaudible in Portsmouth or Winchester may often be distinctly heard from the more open or higher ground outside these towns.

* Knowledge, June, 1901.

The bending upwards or downwards of sound waves, which seems to have presented a problem to Sir John Herschell, has been explained by Sir G. Stokes as due to the general increase of the velocity of wind currents with height above the ground. As a consequence of this he maintains that the front of a sound wave moving against the wind will be caused to lean backwards and therefore its direction of motion to be tilted obliquely upwards. Tyndall accepting this theory, and taking a hinged ladder out on to a common, satisfied himself that a small bell which had been moved to leeward until its sound was inaudible could be distinctly heard when he climbed high enough to catch the sonorous waves that were being deflected upwards.

It is here that I would offer a few observations of my own as mainly supporting the above. On one occasion when making a balloon ascent from Newbury, I caused the tenor bell of Thatcham Church, weighing upwards of a ton, and distant scarcely three miles to windward, to be set ringing as in peal. The wind was a light breeze and the balloon maintained altitudes varying between 1000 and the 3000 feet, yet the bell was inaudible to each and all of the four observers in the car. It is true that for the first few minutes there was much noise in the air occasioned by the shouting of the crowd, but afterwards we travelled only over quiet agricultural country. Another noteworthy phenomenon, to prove which there is abundant evidence, is that when fog signals are being fired from the Bishop lighthouse these will sometimes sound so loudly in the lower part of Hugh Town and Porth Cressa at St. Mary's Island, eight miles away, as actually to shake the houses, while the reports may be scarcely audible from the high and open ground above. Once again I may mention that the guns which, as Dr. Davison states, were unheard at Newbury, forty-four miles away in low ground, were also inaudible from my own grounds in the neighbourhood, which are nearly 500 feet above sea-level. In the above cases due account must of course be taken of any local turmoil in the air which may have tended to mask the distant sounds. In proof of this I may give a recent experiment. A powerful reed was blown at the focus of a large paraboloidal shell, the open mouth of which was directed towards distant clumps of trees in full foliage, when echoes were returned lasting for as much as seven seconds, there being an absence of wind at the time and the summer night well advanced. Other things being equal, however, the same echoes were lost after four or five seconds if there were but faint sounds in the air, such as those of bird or insect life. This is tantamount to proving that a local disturbance which is scarcely noticeable may reduce the range of a given sound by almost one-half.

Further, it may be a question whether the nature of the earth may not in some way affect long hearing. Bearing on this Lord Rayleigh makes the suggestive remark: "The propagation of earthquake disturbance," he says, "is probably affected by the curvature of the surface of the globe acting like a whispering gallery, and perhaps even sonorous vibrations generated at the surface of land or water do not entirely escape the same kind of influence."

Again, surrounding country may make a vast difference in redoubling a sound at any given point or else in allowing it to escape. A remarkable instance of this came under my notice lately. For signalling purposes I was firing gun-cotton fog-signals on the open ground at Cheetham Hill, Manchester, between ten and eleven p.m. These service signals are uniform in character, and the first, though of the usual intensity, was followed by little after-sound. After an interval occupied only by the burning of two distress signals another gun-cotton charge was fired from within a yard or two of the same spot, the reverberations of this, however, were so peculiar and prolonged as to disturb the neighbourhood. If the great difference of after-sound was not due to the slight alteration of position, it can only be referred to the fact that the first cartridge was fired eighteen inches above the ground, while the second was laid on the hard earth, in which it blew a deep cavity.

With reference to the far hearing of bells one most important statement to make is that their sound is extremely uncertain. Seamen, lighthouse keepers and others, whose training makes them close observers, constantly insist on this. I have already shown how remarkably the sound of a bell may be lost in the free upper air. Against this may be quoted a statement which I have on the authority of Messrs. Mears, the well-known bell-founders. It appears that the tenor bell of the peal of St. Bees, on the coast of Cumberland, has been heard at the top of Scafell Pikes, sixteen miles distant in a straight line. This is certainly a record, and must probably be largely accounted for by the slope of the mountain. My own experience is wholly against the possibility of the hearing of a deep bell across such distance and at the height of 3000 feet in the free heaven. The story of the sentry on duty on the terrace of Windsor Castle suspected of drowsiness and yet detecting the clock bell of St. Paul's striking thirteen is quite incredible to one who has frequently and from chosen places of advantage listened to the clocks of London striking midnight. To begin with, hundreds of other clocks are striking at the same period, and for anyone to accurately count out the strokes of any particular bell would require that observer to be very wide awake indeed, and certainly at a nearer distance than twenty odd miles. But a very interesting and instructive series of observations relative to the hearing of a bell heavier by ten tons—namely, Big Ben—has been contributed to the *Quarterly Journal of the Roy. Met. Soc.* by Mr. William Marriott. This observer, making careful note twice daily from a station in West Norwood, only five and a half miles away, records that the bell was very distinctly heard four times, faintly heard 64 times, and altogether unheard on 251 occasions. A significant comment is added to the effect that the most favourable hours were those of evening and Sundays.

Where a bell is chosen for a warning signal, *e.g.*, as on a lighthouse, and it is desired that its sound be carried in all directions over as great horizontal ranges as possible, the most efficient form of sound-board will be found to be that shown in the accompanying figure. Here it will be seen by taking any vertical section of the apparatus that every point on the sound-bow of the bell (*i.e.*, that zone that is in most intense vibration) virtually occupies the focus of a parabolic reflector, and thus the principal sound waves are made to travel outwards horizontally in parallel rays.

An approximation to the paraboloid will be found the best possible form for instruments designed alike to convey and receive the human voice at long range. Obviously some little compromise in outline will be necessary. The aperture of the ear in listening, as also the lips in speaking, should, as nearly as possible, occupy the focus of each instrument. Thus it is clear that the *latus rectum* should not much exceed $1\frac{1}{2}$ inches, and it will then be found convenient that the larger end of the instrument (which may measure some 14 inches in length) should be somewhat constricted so as to approach a cylindrical form. With a pair of these instruments, forming respectively a giant speaking trumpet and a giant ear, speech can be carried on across an open common on a quiet night over a mile range. Any appreciable amount of wind stirring affects results greatly. A favouring wind scarcely favours the hearing of the voice, doubtless largely owing to the murmur in the air caused by the wind stirring the herbage, etc.

It may be otherwise in the case of a gun. Dr. Davison considers that presuming the velocity of wind to increase with height the report of a gun might be audible at a much greater distance in wind than in calm. Tyndall points out that in wind a gunshot may readily be lost altogether, but states as an observation of his own that on a windy day a gun was heard five times and might probably have been heard fifteen times, as far to leeward as to windward.

It has been suggested that the peculiar loudness of some of the reports heard on February 1st may have been due to the discharge of several guns at practically the same instant. This argument may be valid enough in the case of independent but simultaneous gun firing, but it is only true in a very modified degree in the case of the usual gun-cotton fog-signals already spoken of, and chosen by the service for special penetration. The explosion of an eight-ounce cartridge is certainly not nearly twice as loud as that of four ounces, while through interference or some other cause the firing of two four-ounce cartridges in juxtaposition is not very greatly louder than that of one. On an occasion when experimenting on echoes I was firing a number of these fog-signals singly from the clouds I designed to make a superlative discharge by firing a nest of many united together. It chanced that I was able to explode this giant bomb nearly over the racecourse at Epsom at an altitude of about half a mile, the course was deserted, but the nature of the ground seemed favourable for a grand effect. I can but state, however, that the resulting report and subsequent echoes were under the circumstances disappointing.

THE INSECTS OF THE SEA.—V.

By GEO. H. CARPENTER, B.SC.(LOND.), *Assistant in the Museum of Science and Art, Dublin.*

FLIES.

TWO-WINGED flies are perhaps the most dominant of all insects. The woodland rambler in summer-time knows too well what swarms of flies hover with ceaseless buzzing around his head. The individuals of some one kind often occur in countless numbers, and when the flies, now somewhat neglected, have been thoroughly studied, it is likely that their species will be found to exceed in number those of any other insect-order, not excepting even the beetles. Certainly the naturalist who goes to look for insects by the sea-shore in summer-time will first of all be struck by the great abundance of various kinds of flies. He needs not to search for them, as for beetles or springtails, beneath stones; they fly and run to and fro in the sunshine with ceaseless activity.

Among these insects the remarkable modification of the wings of the hind pair into small stalked knobs or "balancers" (*halteres*) leaves the fore-wings alone functional as organs of flight. This character marks the flies as a very distinct order of insects, and suggests for them the expressive name of "Two-wings" (Diptera). In many points of structure flies are the most highly organised of all insects, and their great specialization of form is matched by a great complexity in the transformations that they undergo. The most highly developed members of the order begin life as degraded, headless, legless maggots. The skin of the full-fed maggot hardens to form a brown, egg-shaped puparium, within which first the pupa and then the perfect fly is built up by a profound dissolution and reconstruction of the larval tissues and organs. The despised housefly and bluebottle are proclaimed therefore by their structure and life-history to belong to the highest aristocracy of the insect-world.

Out in the open air one may meet with many hundreds of different kinds of flies more or less related to our well-known guests just mentioned. A vast number of these, which differ from the blue-bottle and its immediate allies in the absence of the silvery scales at the base of the wings, are often spoken of collectively as the "Acalypterata." Quite a little assemblage of these insects haunt the shore just above high-water mark, finding in the cast-up seaweed a playground for themselves, and a feeding-place for their offspring. They are very nearly related to the bright yellow, hairy, red-faced flies of the genus Scatophaga, which may be observed any sunny day in vast numbers hovering over dung-heaps. *Fucellia fucorum* (Fall.), the closest ally of Scatophaga among them, is a small, inconspicuous ashy fly, common on our coasts, and ranging along the western and southern edge of the Continent from Norway to the Adriatic. One other species of Fucellia inhabits our shores, but there are seven or eight

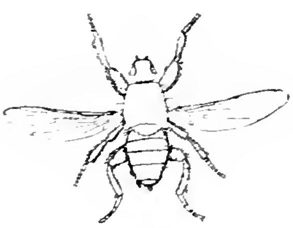


FIG. 1.

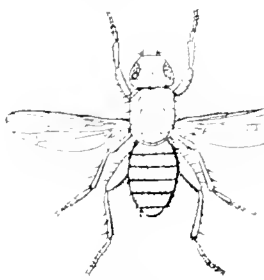


FIG. 2.

FIG. 1.—*Coelopa pilipes*, male. Magnified 3 times.

FIG 2.—*Orygma luctuosa*, male. Magnified 3 times.

different kinds known from the far north of the Scandinavian peninsula—Lapland and Finmark. The flies belonging to Coelopa (Fig. 1) and its allied genera have a most characteristic aspect with their narrow, angular heads, small eyes, and flattened, depressed bodies. They all have stout and powerful legs, which in some species are armed with a most formidable array of spines, while in others they are clothed with a dense setting of long, woolly hairs. The distribution of Coelopa is remarkable. Five or six species inhabit the British and Irish coasts, of which most have been traced to Scandinavia, but only one or two range southwards to Holland and Heligoland, so that the genus is characteristically north-western. Of similar distribution and habits is *Orygma luctuosa*, Meig. (Fig. 2), a somewhat larger fly than the Coelopæ, and distinguished from them by its broad, rounded head.* *Actora æstuum*, Meig., is a still larger fly of an ashy grey colour, less differentiated from related insects than are its comrades of the sea-shore. It is of especial interest since its grub has been described,† and proves to be a greyish maggot with wrinkled skin, fourteen prominent, conical, fleshy processes surrounding the air-openings at the tail-end.

This assemblage of flies, some of whose leading members we have briefly sketched, though few in species, is often very numerous in individuals. On a sunny day, when the tide is high, the observer has but to lie on the beach to watch the ceaseless darting flight of the insects over the seaweed-heaps. Many of the flies follow the receding waves, so that at low-water they may be seen running over the recently exposed rocks or alighting after a short flight on the still damp seaweed.

Many very small flies, belonging to the same great group as those just considered, but to a most distinct sub-family, the Ephydrinæ, also haunt the sea-shore. As usual, a transition can be traced from marsh-dwelling species to those which cling to the tidal margin. Thus the tiny *Atissa pygmaea*, Halid. lives in salt marshes. *Tichomyza fusca*, Macq. is found both on chalky coasts at high-water mark and in the sewers and outhouses of large towns, its grub feeding on decomposing limy material. *Glenanthe ripicola*, Halid. (Fig. 3)

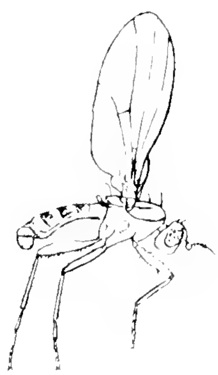


FIG. 3.

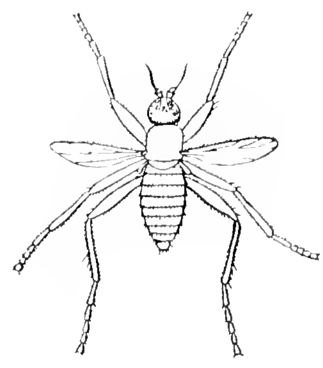


FIG. 4.

FIG. 3.—*Glenanthe ripicola*, male. Magnified 8 times. (After Haliday.)

FIG. 4.—*Chersodromia arenaria*, male. Magnified 12 times.

dwells on muddy sea-coasts, while nearly all our native species of Scatella live among the seaweed masses

* *See* J. R. Schiner, "Fauna Austriaca, Diptera." Wien, 1861-4. F. Walker & A. H. Haliday, "Insecta Britannica, Diptera." 3 vols. London, 1851-6. G. H. Verrall, "A List of British Diptera." London, 1888.

† H. Gadeau de Kerville, "Notes sur les Larves Marines d'un Diptere." *Ann. Soc. Ent. Fr.* (Vol. LXIII.), 1894 pp. 82-5.

thrown up by the tide. Two most remarkable members of this group have been found by the Rev. A. E. Eaton on the shores of the far southern island of Kerguelen.‡ One—*Anomalopteryx maritima*, Eaton, with narrow strap-like wings, haunts the nests of sea-birds; while the other, *Apetenus litoralis*, Eaton, creeps over the stones of the beach.

Several small flies of prey belonging to the family Empidae may be found on our coasts, often occurring in great companies. Though this family is structurally far removed from the groups mentioned above, the sensitive bristle of the feeler, for example, being borne at the tip, not on the edge of the terminal segment, and the grub possessing a distinct head—Haliday pointed out the likeness to Coelopa in the general aspect of these marine Empids. The most characteristic of them belong to the genus Chersodromia. Perhaps the most noteworthy species is *C. arenaria*, Halid. (Fig. 4), in which the wings are so shortened as to be useless for flight—a character, as we have seen, rather frequent among the insects of the sea-shore. Apparently this genus occurs only on our islands and the Scandinavian coasts.

Another family represented on the sea-shore whose members live by prey is the Dolichopodidæ. These are slender, agile flies, often of bright blue or green metallic colours; they are very numerous in species, and often haunt the margins of lakes and streams, running over the surface of the water in pursuit of their prey. Some of the more daring members of this family live close to the edge of the sea within reach of the spray of the breakers, and find their victims in the weaker insects of the shore. Several of the large genera such as Dolichopus and Hydrophorus have each a few maritime representatives, while Machaerium, with only one species—*M. maritimæ*, Halid.—seems to be confined to seaside marshes, and Thinophilus and Aphrosylus (Fig. 5) each with two or three species are only to be

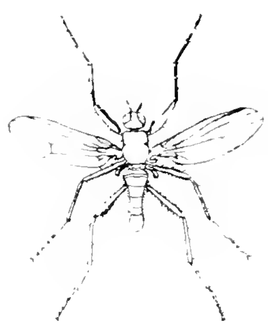


Fig. 5.

Fig. 6.

Fig. 5.—*Aphrosylus raptor*, male. Magnified 3 times. (After Westwood.)

Fig. 6.—Grub of *Aphrosylus*. Magnified 12 times. (After Wheeler.)

found close to the edge of the water, occurring on rocks and seaweed washed by the waves. The species of Thinophilus are bronzy in aspect, but the Aphrosyli have the ashy grey hue characteristic of so many sea-shore insects. The specific names *raptor* and *ferox*, bestowed on them by their describer, A. H. Haliday, sufficiently indicate their habits. For many years Aphrosylus was known only on the British, Irish, and Italian shores, but quite recently three species have been discovered on the Pacific coast of North America by Prof. Wheeler,§ who was fortunate enough to find the curious grub of one of them (Fig. 6) among the seaweed covering the rocks.

But the most perfectly adapted to marine life of all the flies of the sea-shore are minute in size, and belong to one of the lowliest families of the order—the Midges or Chironomidæ. Though small, these are among the most familiar of insects; they may often be seen on a summer evening flying in swarms over the waters of ponds and streams in which their grubs live. The best known species of the family, *Chironomus plumosus*, and its burrowing red grub the "blood-worm," together with some allied forms have been lately described in detail by Miall and Hammond.‖ The Chironomidæ are readily to be distinguished from the gnats or mosquitoes (Culicidæ) by the great reduction of the jaws, which renders them incapable of biting and by the simplicity of the wing-neuration.

One or two species of Chironomus haunt the rocks exposed at low-tide, and their grubs live in the sea as happily as the grubs of their relations live in fresh water. Prof. Miall has found that the fresh water larvæ cannot long survive transference to salt water. Possibly by gradually increasing the degree of salinity, acclimatisation might be brought about in the lifetime of an individual, but there can be no doubt that in the course of generations these marine midge-grubs have become well-used to their strange surroundings. One of them which has been dredged off our coasts from a depth of 15 fathoms was described in the first instance as a marine annelid under the name of *Clunpontia cruciformis*. Except in its colour, which is appropriately a light sea-green, this creature closely resembles an ordinary "blood-worm," possessing a pair of sucker-feet at either end of its body, and tubular "blood-gills" on the two hindmost segments. Mr. Swainson has lately found this grub on hydroids at various parts of the British coast.¶ It may perhaps prove to belong not to a Chironomus in the strict sense, but to the closely allied genus Thalassomyia (which possesses but one species, *T. Frauenfeldii*, Schiner) distinguished by the short, broad and emarginate fourth tarsal segment. On the shores of the Adriatic, this midge was found sitting on rocks within reach of the spray, and it has been noticed on the coast of the Isle of Wight in a somewhat similar situation resting on the walls of a cave, where the spray constantly washed over it.

Marine midges have been found on the other side of the Atlantic. A grub dredged from the depth of 20 fathoms off the coast of Massachusetts and its parent fly were described by Prof. Packard** in 1869 under the name of *Chironomus oceanicus*. As might be expected they have not escaped the notice of French naturalists. In 1892, Prof. Moniez described a marine Chironomus from the shores of the Channel remarkable

‡ G. H. Verrall. "Zoology of Kerguelen Island, Diptera." *Phil. Trans. R. Soc.*, Extra Vol. CLXVIII. 1879, pp. 228-48.

§ W. M. Wheeler. "A Genus of Maritime Dolichopodidæ new to America." *Proc. Cal. Acad. Sci.* (3) Vol. I; 1897, pp. 145-152, pl. 4.

‖ L. C. Miall & A. R. Hammond. "The Structure and Life-History of the Harlequin Fly (Chironomus)." Oxford, 1900.

¶ *See* F. V. Theobald. "An Account of British Flies," Vol. I. (pp. 202-3). London, 1892.

** A. S. Packard. "On Insects inhabiting Salt Water." *Proc. Essex Inst.* (Salem, Mass.), Vol. VI., 1869, pp. 41-51.

in the great divergence between the two sexes, the male having the usual facies of his genus, while the female in some respects seems to approach Clunio—perhaps the most characteristically marine member of the whole order.

The male (Fig. 7) of *Clunio marinus* was described††

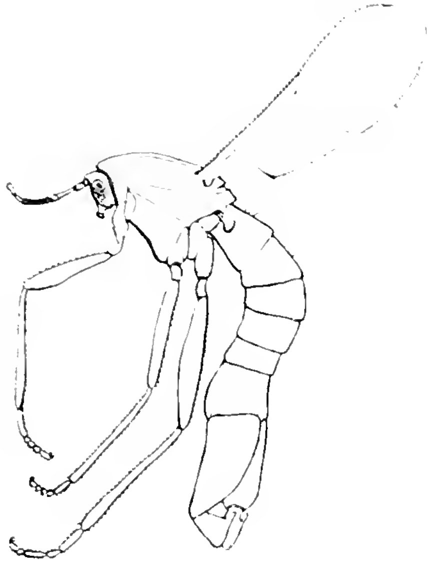


FIG 7

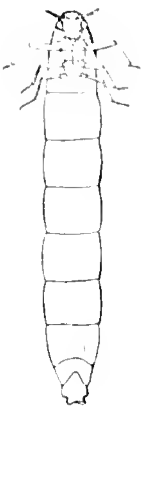


FIG. 8

FIG. 9.

FIG. 7.—*Clunio marinus*, male (side view). FIG. 8.—Female (under view). FIG. 9.—Larva (side view). Magnified 24 times.

forty-six years ago by that admirable Irish entomologist A. H. Haliday, who found the insect in Co. Kerry "on gravelly sea-coasts below high-water mark, walking with the wings half-raised, and in rapid vibration without taking flight." Clunio is readily distinguished from Chironomus by the degeneration of the jaws being carried to an extreme point; only four minute hairy tubercles, representing apparently the lobes and palps of the second maxillæ, can be made out. The eleven-segmented feelers of the male are most characteristic in form; the head is almost entirely hidden beneath the great hood-like forebody shield, while the hinder end of the insect seems disproportionately large owing to the immense size of the genital claspers. This midge is only about 2 mm. long.

"I have observed the insects," wrote Haliday, "only in blustery weather, and could not find any trace of the female among them." She escaped observation indeed for well-nigh forty years; then in 1894 descriptions of her were published almost simultaneously‡‡ by M. René Chevrel, who had been diligently studying the species along the rocky coasts of Calvados, and the present writer, who met with a colony on the shores of Killiney Bay, Co. Dublin. The female Clunio (Fig. 8) is wingless and degraded—almost worm-like with her elongate and (when full of eggs) swollen hind-body, her short and feeble legs, her feelers with only seven reduced segments, and her small eyes.

According to M. Chevrel's observations, Clunio can only be observed during the low spring tides. "One only begins to see them," he writes, "when the rocks where they dwell are uncovered. Few in number the first day, they abound on the morrow and the two following days. Then, becoming scarcer and scarcer, they disappear completely towards the sixth or seventh day, not to be seen again till the next syzygy." Thus periodically they appear from April till October. The males are very active, moving over the rocks and the seaweed—frequenting especially the masses of the bright green Cladophora—or skimming across the surface of the rock-pools. They are in search of the females who creep slowly about among the seaweed. When mating takes place, the male seizes the female with his powerful claspers, holding her by the last abdominal segment, and carries her away with him, her body being almost in a line with his, and her feet, clear of the surface whereon he is walking, kicking in the air. "He takes her about thus for an hour," states M. Chevrel, "then he places her on a rock or an alga. The female, being freed, walks slowly for some minutes, and chooses a suitable spot to lay her eggs . . . She applies the tip of her abdomen to the rock or seaweed and fixes thereto a gelatinous, cylindrical tube wherein the eggs are lodged." These number from 50 to 120. "When the operation is finished, the female, exhausted by the efforts which she has made, can only move slowly; she walks painfully, stops often, and only regains a little strength after resting for several minutes; then she wanders at random and ends by falling into the water, and, floating on the surface, waits for death, which is never long delayed." Often her feet become caught in the gelatinous substance of her egg-tube; she fails to disengage herself and dies resting on her eggs. "The male who has fertilised her," writes M. Chevrel, with a fine appreciation of this little drama of love and death, "does not forsake her; he stays near while the eggs are being laid, then, as if he knew his duty as husband or father, he throws himself upon her to rescue her from the sticky substance, or to carry her with her eggs to a more favourable place for the hatching of the offspring. Sometimes he falls himself a victim to his devotion and dies beside his mate, taken in the same snare."

The shrinkage of the female's body after the eggs have been laid is most remarkable. The degradation of the jaws in both sexes is such as to render feeding impossible, so that Clunio is an excellent example of those insects in which there is a complete division of labour between the larval and perfect stages of the life-history, the former only being concerned with feeding and the latter entirely devoted to reproduction. The life of Clunio as a midge is therefore very short. M. Chevrel could find no trace of them after the tide had covered their breeding-places, and doubts whether they survive either by coming to the surface, or by seeking shelter below. But as he was able to keep specimens alive for 36 hours in captivity, it is likely that they survive from one low tide till the next—especially as a Clunio was discovered in the Adriatic at Trieste among submerged colonies of mussels.

The larva of Clunio is hatched about a week after the eggs are laid, being then only ½ mm. long, whitish and partly transparent. The full-grown larva (Fig. 9)

†† A. H. Haliday. "Descriptions of the Insects figured &c." *Nat. Hist. Rev.*, Vol. II. 1858 (*Proc. of Soc.*, p. 62).

‡‡ R. Chevrel. "Sur un Diptère Marin du Genre Clunio." *Arch. Zool. Exp. Gen.* (3) II., 1894, pp. 583-598. G. H. Carpenter. "Clunio marinus: a Marine Chironomid." *Ent. Mo. Mag.* Vol. XXX., 1894, pp. 129-30. J. J. Kieffer. "Description d'un Diptère sous marin." *Bull. Soc. Ent. France*, 1898, pp. 105-8.

is of a bright green colour, resembling closely that of the Cladophora, among which it lives. The well-developed head with strong mandibles working at an angle against the serrated labial plate, is succeeded by twelve body-segments whereof the first and last bear paired false feet armed with circles of hooklets. Special breathing organs like the gills of a Chironomus-larva are absent; this grub evidently breathes the dissolved air over the whole surface of the skin, a method of respiration common among very small aquatic insects.

Among the insects found by Mr. Eaton on Kerguelen Island is a female midge which resembles Clunio in some particulars. The body is elongate and worm-like, and the wings are reduced to small vestiges, but the legs are relatively very long and the hind-body ends in a pointed ovipositor (Fig. 11). This southern Chironomid —*Halirytus amphibius* is its name—was found "at the verge of the tide, creeping over Enteromorpha and mussels exposed by the recess of the sea, and walking upon the surface of puddles and tide-pools. The fly was common upon some small isolated rocks which were always submerged at high water. The adults in that locality must spend a large portion of their lives under water. Probably whenever the water has retired sufficiently from the top of the rocks, all the flies hurry up from below to take an airing."

Another tiny marine midge (Fig. 10) has lately been

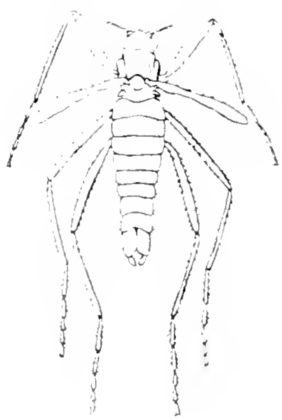


FIG. 10.

FIG. 11.

FIG. 10.—*Eretmoptera Browni*, male. Magnified 15 times. (After Kellogg.)
FIG. 11.—*Halirytus amphibius*, female. Magnified 12 times. (After Eaton.)

discovered on the rocky coast of California, and named *Eretmoptera Browni* by Prof. Vernon L. Kellogg.§§ On account of its very remarkable structure its describer considers it the type of a distinct family. In both sexes the wings are "narrow and strap-like and wholly without veins . . . not specially thin or delicate, but rather thickened." The hind-wings, instead of being the stalked knob-like "balancers" usual among the Diptera, "are minute scale-like processes appearing like rudiments of wings" of the ordinary type. It is possible, therefore, that this midge may represent a very early stage in the evolution of the Diptera, before the characteristic "balancers" had become specially modified. "The flies, of which there were many, were resting or running on the surface of the ocean water of tide-pools, and had a tendency to gather in large numbers in patches and in ball-like masses on the water." The discovery of this most remarkable midge shows what wonders of insect life may still await the diligent observer by the sea-shore.

Reviewing generally the marine flies here briefly sketched, it will be noticed that they show a strong tendency towards the reduction or total loss of their wings. It will be remembered that a similar tendency is found among the marine beetles, but the flies are such typically aerial insects that loss of flight among them is especially remarkable. In a well-known passage Dr. A. R. Wallace|| has pointed out that the insects inhabiting oceanic islands are often flightless, and he explains this as due to the action of natural selection; when flying individuals are liable to be blown out to sea, it becomes a positive advantage to the species to lose the power of flight. This state of things seems to be carried to an extreme on the far-off wind-swept island of Kerguelen. There can be little doubt that life by the sea-shore is rendered safer for insects, when through loss of the power of flight, they have ceased to expose themselves to the full power of the wind. And thus the degradation which they have undergone is the price of a more perfect adaptation to the strange surroundings which their ancestors chose long ago.

ROUND FAIR HEAD.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S.

THE north-east of Ireland is essentially the land of Scots. From the third to the sixth century, its enterprising sons went forth, ran their light curraghs into the harbours of North Britain, held their own in that rugged country, and gave their name to Scotland. In the sixteenth century, the MacDonnells of the Isles, thirsting for a wider empire, returned to their ancient homes in the valleys that cut the Antrim plateaux, and sought to establish themselves amongst the Irish, who had almost forgotten the relationship. These Scots, indeed, had to win back the land which their ancestors had forsaken, and they form a population between Ballycastle and Cushendall, Scottish and distinct, still preserving the old religion, which was common to all at the time of their return.

In the midst of their territory rises the promontory of Benmore, Fair Head, as the English have called it, a worthy opponent to the great headland of Kintyre, which faces it fourteen miles away across the sea. There is no more distinctive feature in the county of Antrim than this sheer cliff-wall, with the rugged talus at its foot, a buttress to the coast, a defiance to the northern storms.

From Ballycastle on the west to the woods of Murlough Bay upon the east, the great crag dominates the landscape. Its essential characters become best revealed if we approach it from Ballycastle Bay.

South of us, on the broad dome of Knocklayd (Cnocleithid), we have an epitome of the most momentous phases of the geological history of Co. Antrim. The base of the hill consists of old micaceous schists, rocks

§§ V. L. Kellogg, "An Extraordinary New Maritime Fly." *Biol. Bulletin*, Vol. I., 1900, pp. 81-7.

|| A. R. Wallace, "Darwinism." 2nd Edition (pp. 105-6). London, 1889.

that have been squeezed and uptilted at a very early period. They are contemporary with the central masses of the Grampians. But above them runs a level band of chalk, encircling Knocklayd, with, above that again, up to the summit, 1700 feet above the sea, the brown-black basalts that are so familiar throughout Antrim and the western isles of Scotland.

The "white limestone," or chalk, is a relic of the material that once stretched across the country, deposited as fine ooze by the organisms of the Cretaceous sea. The sea-floor was raised by the mysterious and recurring earth-movements; the chalk became attacked by rain and rivers, and was converted into grassy downs, such as we see to-day in south-east England. Then, in what are called Eocene times, volcanoes broke out all across the area;* stream after stream of lava was poured over the blackened downs, filling up the hollows, choking the valleys, and finally burying the older features in continuous sheets of basalt. In our own times, these sheets have given rise to the high plateaux of the north, just as they form the tablelands of Trotternish in Skye and of the west of Mull, intersected here and there by ravines and valleys, into which their *débris* are swept down. Knocklayd is an outlying mass, cut off from the main plateaux by denudation, and forms a fitting introduction to the story of Fair Head itself.

We leave the blown sand that gathers in Ballycastle Bay, and before us rises the long wall of cliffs, culminating in the sharply defined crest of Benmore, a columnar façade erected, as it were, by titans. Yellow and grey sandstones, cut here and there by dykes of basalt, flank our route at first; and then we come unexpectedly on a little coal-mine, burrowing into the face of the cliff, and bringing out its black heaps against the road. We have here, in fact, the same strata, low down in the Carboniferous system, as those in which coal is successfully worked near Edinburgh. Further on, where the road becomes a mere track, climbing above slopes of grass, we find the yellow sandstone worked in a high quarry, from which the crane lowers the blocks for shipment at a tremulous pier. It is odd to note here the coal-seams exposed upon the natural surface of the cliff, and showering down their black detritus on the pathway. On our left, across five miles of gleaming water, Rathlin Island smiles in sunlight, its strip of chalk capped by a basalt layer, a mass detached from Antrim by the wash of waters round it.

It was my fortune thus to view it on the third of January in the present year, one of those fresh and brilliant days that are far more common in a highland winter than we realise among the fogs of towns. There certainly was nothing to suggest the bitter tragedies of 1575, the slaughter of enfeebled Scots up and down the plateaux, the relentless hunting of women and children through all the white caverns on the shore.

And now the path rises further, up the side of a waterfall, which comes leaping down the flank of Sron bane, a projection perhaps named from its contrast with the sterner mass beyond. The foot-track is for us no longer; we must take to the slopes of grass, and trust to our wits to bring us round.

Half-a-mile further, the first blocks of basalt cumber the ground; above us we see the sandstones seamed with horizontal sheets of lava, which have worked their way in between them, baking them as they went. These are the offshoots of the great volcanic knot of Fair Head, a huge intrusion of molten matter, now cold and crystalline, which forced its way in among the older rocks during the earth-storm that once raged in Antrim. Those who know Staffa or the Giant's Causeway will recognise the volcanic rocks above us now. The sheets have shrunk on cooling, have cracked transversely, and a range of columns results, giving to the cliff-face the likeness of a gigantic organ. We soon see that this columnar structure, becoming more coarse and bold in Benmore itself, is responsible for the characteristic sheerness of the mass. The columns break off along the joint-planes, and provide the formidable blocks, clean in the side, sharp at the angles, which are added yearly to the talus.

And soon this manifold talus threatens us. Hitherto the sandstones have furnished us with ledges, on which the grass gives foothold; it has been easy to climb to the base of the cliff-wall, or to descend to the terraces along the shore. But now, across the rivulet that falls in cascades out of Lough Doo, the streams of stones stretch down seaward, bare and continuous, from the crag. Each has to be crossed with forethought; a grassy interlude may or may not lie beyond it; it is certain that another stone-stream will appear to bar the way, hidden by the one with which we are immediately concerned. Some of the individual blocks are large enough to be identified miles away. Thus the projecting masses, heaped on one another below Lough Doo, four or five together, form a group which is descried from Ballycastle.

A stout stick without a ferrule, which will not slip when the weight is thrown on it, serves one well amid this scene of desolation. The camera is strapped firmly on the back, the geological hammer is thrust into the collecting-bag, only to be produced when wanted; for the two hands are here as useful as the feet. A good walker has twice rounded Fair Head in a day, jumping from block to block. For the ordinary person—and he should be one who knows something about taluses—I would say, neither begin to jump, nor hesitate at any point too long. The experience gained on ordinary "screes," where one can thrust a long stick against the slope above one, and ascend the more stable blocks as on a staircase, avails one little on Fair Head. The walk is an almost continuous scramble, and it seems a matter of chance whether one succeeds or fails. Two men together should be almost certain to succeed. One man alone may find it more discreet and business-like to fail.

Though the whole crag rises only 636 feet above the sea, the sense of gloom, of voiceless walls of rock, of absolute and naked savagery, soon becomes impressive and supreme. The cliff above is unnotched throughout a barren mile, a mile that may occupy an expert for an hour, a cautious walker for two or more. Once round the northern angle, the view widens, and Scotland grows clear across the sea. The high masses on Kintyre loom up near at hand; Islay lies out there to westward; and between them, pink with haze, or just caught by a wisp of sunny cloud, we may see the Paps of Jura, and the long ridge stretching up to Lorne.

A startled gull wheels up crying from below us; above us towers the impregnable fortress, steel-grey, gloomy, and impenetrable. The blocks over which we scramble seem rarely less than ten feet long; they are sometimes as large as a cottage, set obliquely or on end. Between them, the interspaces would easily admit

* *See* "Volcanoes of the North," KNOWLEDGE, Vol. XXI. (1898), p. 266.

a man; and small chance of succour from Murlough or Ballycastle comes that way. The absence of small stones makes the Fair Head talus in certain places almost gruesome; the fissures widen out into caverns, which have no true floors, but from which one might slip, down the face of one stone or another, till the earliest and lowest layer of the mighty pile was reached. Fortunately, the sharpness of the edges and the angles prevents movement of the blocks themselves; a rocking stone is scarcely met with, and foothold on the crystalline dolerite is secure.

At one point, a huge mass of columns has slid down the cliff-face without serious fracture, and remains propped up against its parent, a giant's step to the summit of the wall. Below it is one of the roughest streams of *débris*; then again an easier interval, with tufts of grass and moss, forming bridges that are often serviceable enough. Again and again an ordinary mortal has to let himself down over a joint-face by his arms, to find a foothold on the angle of some lower stone, and then to climb out on the opposite side, like a spirit escaping from a tomb.

All this is no doubt exhilarating, but equally laborious; on this winter's day, despite the superb clear weather, I confess that I was content to fail. I had thought of gaining the grassy paths of the old collieries in Murlough Bay, and returning serenely by the Ballycastle road; but, close against the goal, there runs a deep channel in the talus, with blocks of forbidding bulk upon its southern side. I scrambled up and down, could not see my passage, except into the mysterious and communicating vaults below, and preferred to return over the way already known. The strange character of the talus was demonstrated by the fact that again and again one crosses a piece of broken ground by the same stones or the same gaps that have been selected on the outward way. The choice on the return journey is limited by the fact that there is often one passage, and no other. Again I write for the very ordinary mortal; the talus might seem a Jacob's ladder to a cragsman.

The landmarks by which progress can be reported are the great erratic stone on the very edge of the cliff, left there during the ice-age, before the crag was carved back to its present line; this or that conspicuous block, resting freshly on the apex of a grey stream of its predecessors; or some feature of the columns on the wall, such as the point where they are undercut, and actually overhang the base. The scale of the rocky landscape is so large that one hails the passage of these points in succession, until the last wedged up and projecting pile comes in sight, close against the streamlet from Lough Doo. Even here, there is a climb down to the grass-slope before the grim masses are forsaken. And thence it seems gentle enough to Ballycastle.

Murlough Bay, if one should reach it by this route, or by the legitimate road across the headland, presents beautiful rock-contrasts, even to the untrained eye. The cliff of chalk, high above the wooded combe, rests on red Triassic strata; these again have a foundation of old crystalline schists. Above the whole, grey in the north-west, the dolerite crag of Benmore rises, as a memorial of the volcanic epoch to which we owe equally the high ridge of Slemish, and the mosaic pavement of the Giant's Causeway. Along this coast, the form of Fair Head perpetually haunts us; some artist should record it in a hundred aspects, as Hokusai painted Fujiyama.

THE RINGED PLAINS OF THE MARE NUBIUM.

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

THE accompanying photograph was taken by MM. Lœwy and Puiseux at the Paris Observatory on 1896, September 29. A portion of this same region—the western shores of the Mare Humorum—was given in the December number of KNOWLEDGE for 1899, under the title of "Hippalus and its Surroundings," and was an enlargement from a photograph taken at the same observatory on 1896, April 23. In the earlier paper, attention was chiefly drawn to the deep clefts in the mountainous region west of the Mare Humorum, which follow the outline of the sea itself; to the bold ridges in the sea, which are roughly parallel to both the clefts; to the border of the *Mare*, and to the ramparts—broken down or completely submerged on the seaward side—of the walled plains that are set round the Mare Humorum.

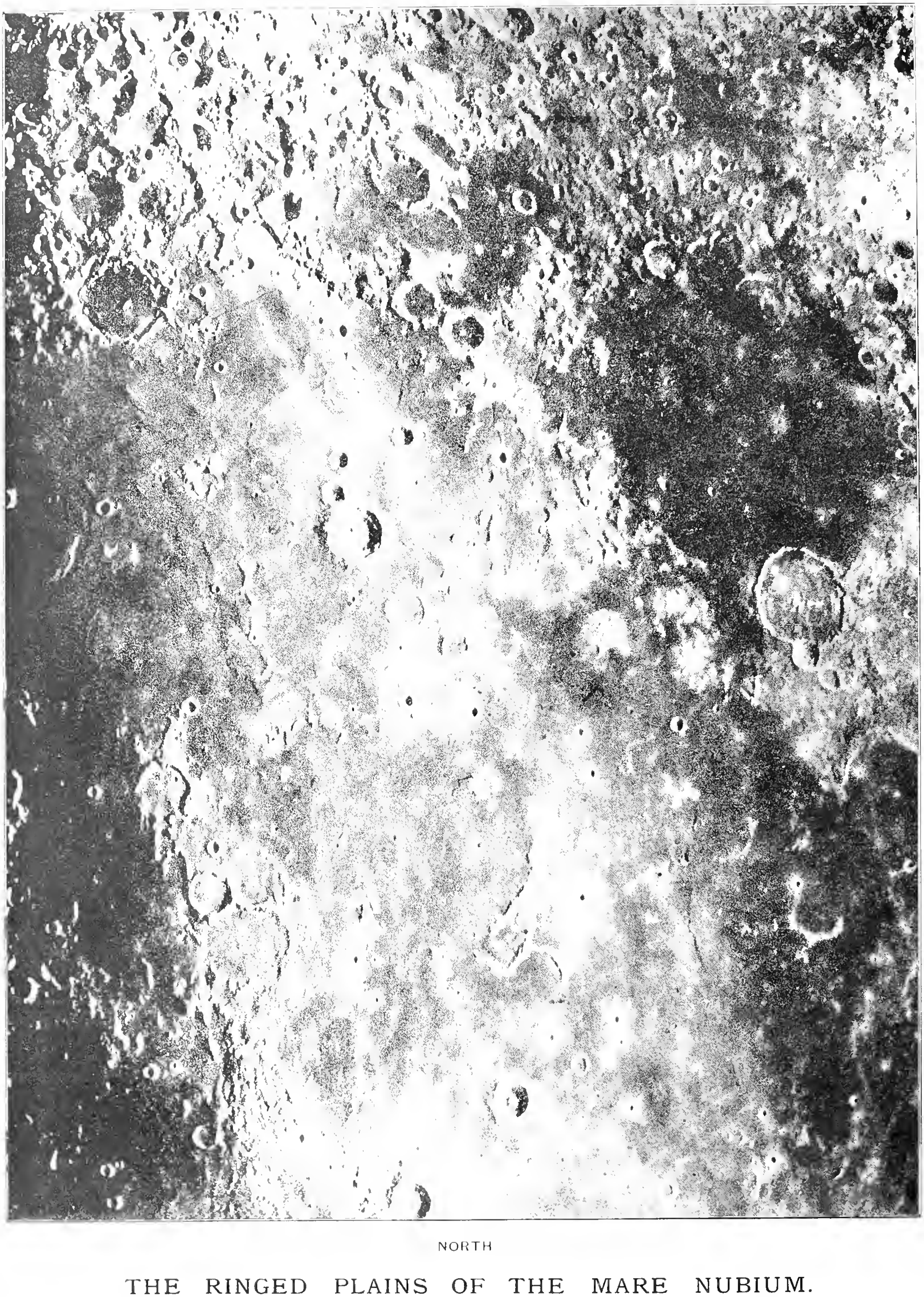
The present plate covers a much wider area. Stretching along its south is a very mountainous and disturbed region, where great ringed plains and rough congeries of unshapen hills seem at some early date to have striven together for supremacy, and where both, indifferently, are now pockmarked by the small deep craters of later convulsions. Hainzel is half out of the picture. Heinsius, almost eaten up by its three parasitic craters, is on the border to the west. The giant triplet of Pitatus, Gauricus and Wurzelbauer are almost on the terminator, and Capuanus, Ramsden, Mercator and Campanus lie in the southern centre.

To the east and north-east are the Mare Humorum and the Oceanus Procellarum. The first is not well seen on this photograph owing to the conditions of the exposure and development, but the huge walled plain, Gassendi, on its northern shore, is very well shown, and the highlands which extend from it to the borders of the ruined plain Letronne.

The whole centre of the photograph is occupied by the Sea of Clouds, and its floor presents a study of walled and ringed plains, in all states of preservation and decay. Bullialdus, the greatest and deepest of those on the floor of the sea, seems also to be of the most recent date, and from its south-west border there comes a curved chain of four craters, Bullialdus A, B, C, and Agatharchides A, the largest craters in the *Mare*.

To the north, Lubiniezky is evidently much more antique, and its ramparts are weathered to a smooth round curve; its floor is flattened to a dead level, and neither Schröter, Mädler nor Schmidt have been able ever to detect any irregularities upon it. In the photograph, the wall has a distinctly horse-shoe appearance with the opening to the south-west, but Neison draws a continuous ring, as distinct on the south-west as on the north-east. Close examination of the photograph shows that the wall is continued right round, four buttresses apparently blocking the entrance to the horse-shoe.

In a much worse state of preservation is Fra Mauro, which lies further to the north-west and almost on the terminator. At some places its wall is very much defaced, in others quite broken down. In its eastern border, there is a deep irregular depression which is continued towards the north through the highlands and the low-lying country beyond, as far as to the east of Gambart A, and cutting the ringed plain of Fra Mauro in two and passing through its central craterlet, is a very delicate and fine rill which Neison traces from the



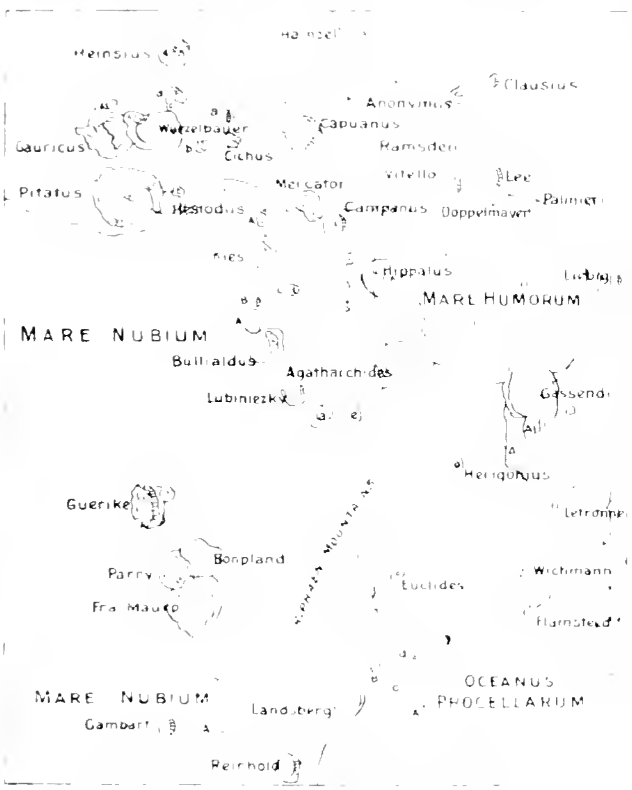
NORTH

THE RINGED PLAINS OF THE MARE NUBIUM.

From a Photograph taken 1896 September 29, 16·0h Paris Mean Time, with the Great Equatorial Coudé of the Paris Observatory.
Scale—Diameter of Moon, 23 inches. Moon's Age, 22d. 14·1h.

mountainous district to the north, through the plain, and along the floor on the base of the eastern rampart of Parry, and skirting the eastern flank of the crater Parry A.

There are several of these very delicate rills seen on the photograph. They usually appear crossing the floor of one of the ancient walled plains. One stronger than that crossing Fra Mauro, traverses Letronne from north to south, and seems to end in the highland country lying between Letronne and Gassendi. Another and very remarkable one, not mentioned by Neison, cuts Gassendi itself right across from east to west. It seems to mark the limit which the Mare Humorum would have reached had not the ramparts of Gassendi been already there, and it is a continuation as a *rill* of the mountain *ridge* that forms the eastern border of the *Mare*, and that joins the rampart of Gassendi immediately to the south of the triangular ridge, Gassendi II. This eastern border of the Mare Humorum



Key Map of Plate.

is itself a remarkable object. It is evidently complementary to the three deep parallel clefts on the western banks of the sea, but in its northern part it is decidedly a ridge; in its southern, where it passes through Doppelmayer *g*, its nature is doubtful, for Neison calls it a "rill" there, and Loewy and Puiseux term it a "terrasse."

About half-way between Bullialdus and Guerikė, and slightly inclined to the meridian, is seen a chain of three or more ringed plains far advanced in ruin. At least the photograph presents them almost unmistakably as ringed plains, but Neison in his "Moon" figures only the most northern member of the chain as such, not perceiving the western or separating walls of the more southern. At the north-east and south-west corners of the central plain, where it cuts the outer members of the chain, are two craters of comparatively recent origin, and a straight rill unites the two and tangential to their north-western flanks. We seem here to see the cause of the ruin and semi-obliteration of the ringed plains in the conjunction of rill and crater, both signs of weakness in the lunar crust, and causing subsidence on one side and upheaval on another.

Due east of the triplet of walled plains Fra Mauro, Parry and Bonpland, and about half way between them and Wichmann, lies a curved and continuous range of hills, the Riphaen Mountains. The curve of these hills appears on the photograph to be continued towards the west and then round to the south by a series of isolated peaks, and the central floor is smooth and unbroken save for a pair of very small craters, so that the impression is given that here we have the remnants of a huge walled plain, many times larger than Gassendi, whose ramparts are still intact on the east, much broken towards the north and west, and entirely submerged towards the south.

Still another instance the photograph seems to give of a walled plain that has now become not only partially but entirely submerged. To the south-east of the Riphaen Mountains are two craters, Herigonius B and C; and round C, the more southern of these, is seen a broad circular dark marking that looks like the wall of an ancient plain that has been not only levelled, but even depressed below the surrounding surface by the action of the great central volcano.

The most perfect and stable in appearance of all the walled plains seen on the photograph is Gassendi. The north-east corner shows a marking on the floor which forms a curious copy of the shape of Gassendi itself with its great parasite ringed plain, Gassendi A, hanging on its northern border.

Two other curious markings are seen, triangular in shape. One is the deep right-angled triangle that is stamped on the northern spur of the Riphaen Mountains, the other is a deep triangular impression in the mountainous region to the south of Cichus A.

THE GREAT SOUTHERN COMET (1901 I).

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

The brilliant comet which suddenly appeared in the morning sky on April 24 incited widespread observation and comment from southern observers. The merit attaching to its first discovery apparently rests with Mr. Arthur Hills, of Queenstown. The object, apart from its conspicuous and almost startling aspect, formed a view, very picturesque of its kind, in the twilight over the eastern horizon. It exhibited a short, brilliant and almost vertical tail with a dark rift running lengthwise along its central part, and during May there was a long filmy streamer, or faint secondary tail, directed to the south and inclined at an angle of about 35° to the brighter tail. Major Eddie, who obtained some magnificent views of the comet at Naauwpoort, S. Africa, says that on May 6 "the bright straight tail with its faint extension was about 16° long, reaching nearly to Rigel, while the enormous lateral emission of shimmering light flooded the S.W. sky with a ghostly gleam 40° long, 6° to 10° broad; while the whole space between this mighty extension and the more brilliant tail was filled with a gauze-like sheen." (*B. A. A. Journal*, June, 1901.)

Several of the observers may be said to have discovered the comet for themselves, for they had no intimation of the presence of the brilliant visitor until they saw it shining in the sky. When it was first noticed it was situated to the S.W. of the sun, and in perihelion: a few days afterwards it passed about 15° south of the sun, and became visible in the evening sky. The faint broad stream of luminous material which formed the secondary tail was curved near its southern extremity, and it remained visible, under various modifications, from May 2 to 27. It may be interesting to summarize the estimated lengths of the two tails, as given by several observers:

Date.	Bright Tail.	Secondary Tail.	
April 25	10	...	R. T. A. Innes, Cape Town.
May 6	7½	30	J. Lunt, Cape Town.
„ 12	7	25	J. Lunt, Cape Town.
„ 5	10–12	25–30	J. T. Bird, Dullstroom, E. Transvaal.
„ 3	> 5	—	C. J. Taylor, Cape Town.
„ 9–11	8–10	20	C. J. Taylor, Cape Town.
„ 15	—	23	C. J. Taylor, Cape Town.
„ 6	5–10	25–30	A. M. Megginson, Sydney.
„ 6	8	25	C. J. Merfield, Sydney.
„ 2	5	—	L. A. Eddie, Naauwpoort, S. Africa.
„ 3	—	10	L. A. Eddie, Naauwpoort, S. Africa.
„ 4	—	12	L. A. Eddie, Naauwpoort, S. Africa.
„ 5	12	20	L. A. Eddie, Naauwpoort, S. Africa.
„ 6	16	40	L. A. Eddie, Naauwpoort, S. Africa.
„ 8		40	L. A. Eddie, Naauwpoort, S. Africa.
„ 10	12–14	25–30	L. A. Eddie, Naauwpoort, S. Africa.
„ 11	16	—	L. A. Eddie, Naauwpoort, S. Africa.
„ 14	18–20	30–35	L. A. Eddie, Naauwpoort, S. Africa.
„ 19	15	25	L. A. Eddie, Naauwpoort, S. Africa.

The comet remained prominently visible to the naked eye until about May 27, after which moonlight practically obliterated it, but Major Eddie watched it in a field-glass until June 10, when it appeared as a faint nebulous streak. (*B. A. A. Journal*, June, 1901.)

A large number of descriptions and drawings of the comet have been received from S. Africa, Australia, and other regions, and a number of these have been published in the scientific journals. A series of sketches were made by Mr. C. J. Taylor, of Cape Town, and these show the general aspect and approximate positions of the object very well. Possibly, however, the angle between the bright main tail and the faint long streamer is not represented sufficiently great, as photographic views of the comet show the inclination to have been about 32° on May 6 and 7.

Mr. Taylor, writing on May 28, from Kenilworth, Cape Town, says:—"On the morning of April 27, I caught a glimpse of the comet, but it was too near the sun to be observed with advantage. On May 3 it was observed directly after sunset, and was a very conspicuous object on the 4th, when the tail was over 4° in length and divided in the middle by a clear dark space, the preceding portion being much wider and more defined than the following. A shorter secondary tail, very indistinct, was to be observed in the telescope sweeping to the east. The comet became a splendid object thereafter and was seen to the greatest advantage between the 6th and 15th, the best views being obtained on the 9th and 11th, when the main tail extended over 8 to 10°, still being clearly divided; while the secondary and fainter tail made a graceful sweep over fully 20°

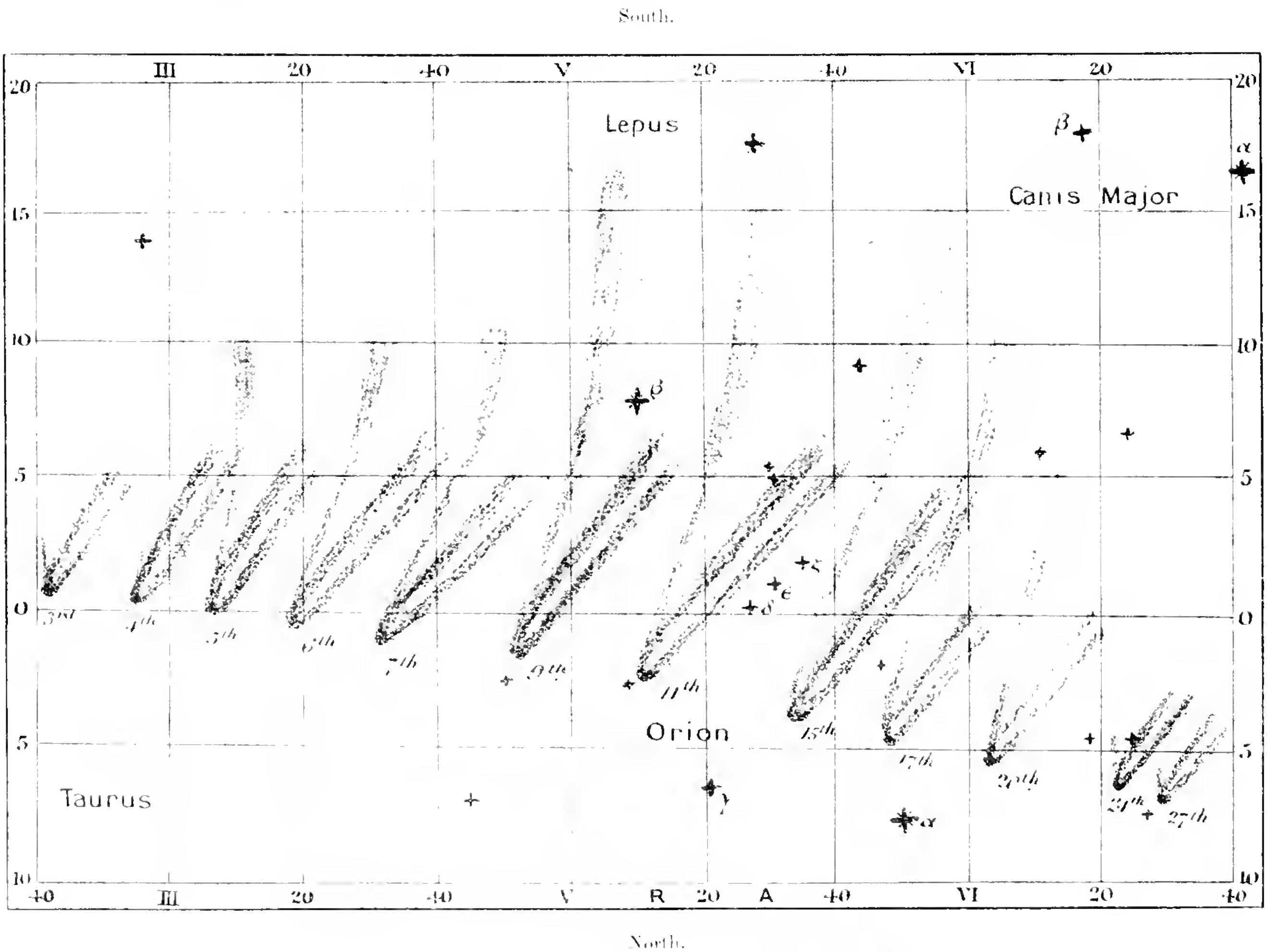


Fig. 1. The Great Southern Comet (1901 I.) From sketches by Mr. C. J. Taylor.

and could be traced to α and β Leporis. The head was very bright and about equal in diameter to Mars at present. On the 15th the fainter tail was about 23° long and reached nearly to β Canis Majoris. Since then the comet has declined rapidly and at present, owing to the moon, is practically invisible to the naked eye, though easily picked up in the telescope. From the 5th to the 15th there were apparently two fainter rays or tails to be seen on either side of the main tail. I attach a rough chart showing the positions of the comet from May 3rd to the 27th, the sketches of the 4th, 6th, 9th, 11th, and 15th, in particular giving the general appearance of the object on these days as seen in a $3\frac{3}{4}$ inch equatorial by myself."

Mr. H. Farnill-Scott, of Fort Hill, British Central Africa, writes on May 23 :—"While proceeding on Government business up Lake Nyasa on the s.s. 'Adventure,' I observed a comet, and thinking some details of its appearance may be of interest I venture to submit the following excerpts from my diary. I may mention that some few days previous to my noticing the comet my friend, Lieut.-Commander E. J. Sparkes, R.N.R., remarked to me at Fort Johnston that he had observed a comet on April 27 or 28 just before sunrise, and situate some 10° below the morning star; this, I presume, is the same object as that observed by me.

"May 2, 1901. At 6.30 p.m., immediately after sunset, when off Usiska on the western shore of Lake Nyasa, in latitude 11° 8′ S. and longitude 34° 12′ E., I observed a bright comet travelling due north at an angle of 30° with the horizon. The tail appeared as a single column of light slightly wider at its furthest distance from the head and brighter at its edges than in the centre, the upper edge being the brighter and slightly convex. The head seemed surrounded, at any rate, in front, by a dark zone. Moon nearly full; the comet disappeared behind a hill at 7 p.m.

"May 3, cloudy. May 4, arrived at Karonga, latitude 9° 90′ S., longitude 33° 9′ E. Noticed the comet at 6.40 p.m., and the moon not being quite up, it appeared brighter and the tail seemed longer. It set about 7.40 p.m., the tail being visible for some little time longer.

"May 5. Saw the comet at 6.55 p.m.; it was situated then directly under the belt in the constellation Orion and looked much brighter; it set about 7.20 p.m.

"May 6, cloudy. May 7. The comet came into view at 7.14 p.m. The tail was now much brighter and showed some signs of cleavage, the upper portion being almost parallel with the sword belt of Orion. Set at 7.27 p.m.

"May 8, 9, and 10. Kept the comet under observation with varying success, due to the presence or absence of cloud and rain; its angle with the horizon had become more vertical.

"May 11. This evening I watched the comet from 7 to 7.36 p.m. The tail now partook of a V-shape, the upper rays being still brighter than the lower ones and still convex, the two sets of rays embracing Orion's sword. The meridian line between the two sets of rays formed an angle of 45° with the horizon.

"May 12, 13, and 14. I was down with malarial fever and could make no observations of the comet, but was informed that there was apparently little or no variation from its appearance on previous evenings.

"May 16. Watched the comet from 7 to 7.50 p.m. It seemed to be waning in brightness and visible to a later hour, being higher in the heavens.

"May 17, cloudy. May 18. This morning there was a partial eclipse of the sun. In view of this I was up betimes (4.30 a.m.) hoping to get a morning view of our celestial visitor, but was disappointed, the atmosphere being laden with vapour. Saw the comet again in the evening at 7.10; its angle with the horizon was 60° and it was much dimmer though still quite distinct. The tail was clearly visible after Orion had set. It was much farther north than when I first saw it on May 2. Set at 8.3 p.m.

"May 19 to 22. Though keenly looked for, I was unable to see the comet; these evenings were cloudless and starlight."

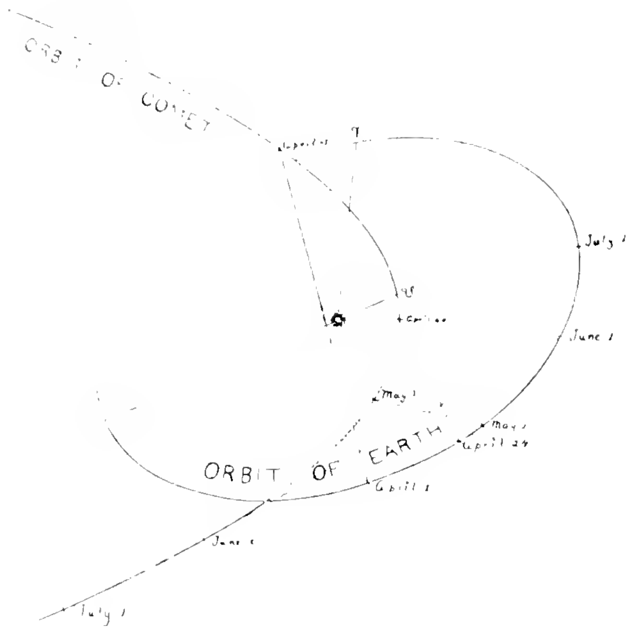


FIG. 2.—Orbit of the Comet and Earth. From *Popular Astronomy*.

The suddenness of the comet's incursion is explained by the path it pursued relatively to the orbit of the earth. It rapidly approached perihelion from the opposite side of the sun to the earth and then the solar rays veiled its approach until, having considerably increased in brilliancy and developed a fine tail, the sun could no longer afford an effectual screen. The comet was then detected even amid the strong light of the circum-solar region, and when it was only 12° distant from the sun. The conditions of its approach were such that regular comet-seekers had very little chance of discovering it, for it was very distant in the earlier months of the year and must have been extremely faint, though projected on a dark sky. And the comet went as it came, under circumstances which prevented it being traced but for a comparatively short interval. When the comet was first seen it was in the eastern extremity of Pisces and travelling rapidly eastwards. Traversing the head of Cetus, it passed between Taurus and Eridanus, was very finely displayed when amongst the well known stars of Orion and was finally lost as a naked eye object when situated in the head of Monoceros. The comet seems to have been observed at only three northern stations, viz., at the Lick and Mount Lowe Observatories, California, and at the Yerkes Observatory, Chicago.

Very little information has yet been published as to spectroscopic results. Sir D. Gill states in the *Monthly Notices* for June that "the spectrum of the comet appears to be continuous; at least with the means at our disposal we have been unable to detect any bright lines."

Elements of the comet have been computed by H. Thiele, of Bamberg (*Ast. Nach* 3731), from observations on April 24 (Cape Town), May 2 (Windsor), and May 15 (Mount Hamilton), and they are as follows:—

$$P.P. = 1901, \text{April } 24{\cdot}28821, \text{M.T., Berlin.}$$
$$\omega = 203^\circ\ 1'\ 15''{\cdot}8.$$
$$\Omega = 109^\circ\ 44'\ 1''{\cdot}0$$
$$i = 131^\circ\ 1'\ 7''{\cdot}9.$$
$$\text{Log. } q = 9{\cdot}388046$$

The perihelion distance was nearly 23 millions of miles, so that this comet did not, like the great southern comets of February, 1880, and January 1887, pass very close to the sun.

The astronomical discoveries that will be made during the present century will undoubtedly be very numerous and some of them brilliant, but it will be difficult for it to furnish a parallel to the first few months of its opening year with its brilliant star and its great comet.

Letters.

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

NOVA PERSEI

TO THE EDITORS OF KNOWLEDGE.

SIRS,—With reference to the photographs of the Nova Persei region in the July number of KNOWLEDGE, my attention has been kindly called independently by two of your readers, Mr. J. E. Davidson and Mr. J. E. Gore, to what is apparently a bright star visible on the photograph of Feb. 28, but absent from that of Feb. 20. It will be readily found at a short distance south-east of the bright star 56 Persei, visible near the upper (north) part of the photograph. Reference to the original negative shows, however, that this object is not the image of a real star, but is due to a spot on the film; and it is absent from another photograph taken upon the same night.

Now that Perseus is coming round into a favourable and convenient position for evening observation, no doubt many observers will contemplate looking up the Nova, and hence it may be of interest to state that the star is still a fairly bright object. On several occasions lately it has appeared between 6 and 6½ magnitude; and on the nights of the 9th and 10th August, it was plainly visible in an opera-glass. The intense red colour formerly characterising the object seems, however, to have almost entirely disappeared.

A. STANLEY WILLIAMS

Brighton, 1901, Aug. 12.

DOUBLE RAINBOW

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Whilst staying at the Goschenen Alp in July last a thunder-storm accompanied by heavy rain passed overhead one afternoon about 5 o'clock. It was not of long duration, and the sun soon shone out brightly from below the western margin of the storm clouds, whilst the rain was still falling copiously at the eastern end of the valley. On this rain a double rainbow of considerable brilliancy was produced and persisted for 5-10 minutes. Not remembering to have seen a similar phenomenon, I venture to mention it to the readers of KNOWLEDGE and to ask for some suggestion as to the probable cause. This was not an ordinary case of a primary and secondary rainbow where the secondary is seen high above the primary and with the sequence of the colours reversed, but there were two rainbows immediately one within the other, both equally bright and broad and the colours in each following the same order as in that of a primary bow—the red of the inner bow and the violet of the outer being apparently in contact as closely as the other bands of colour usually are seen. It occurred to me that there might possibly have been two showers falling at the same time with a dry interval between, and that I had seen a rainbow upon each at such an angle as to exhibit one in apparent contact with the other, but of this I cannot be sure. The rain as it passed over me was a continuous shower, and the length of the clear open portion of the valley down which the storm drifted was not much more than a mile.

R. T. LEWIS.

Ealing, W.,
1901, August 2.

[The double rainbow, to which reference is made in the above letter, was probably an ordinary primary bow with a bright *supernumerary* bow adjacent to it on the interior edge. The appearance cannot be explained in the manner suggested by Mr. Lewis, nor by any simple geometrical theory. Supernumerary bows, of which several are sometimes seen on the inner edge of the primary bow, and occasionally on the outer edge of the secondary bow, are due to the interference of light, and the angular distances between them and the principal bow depend upon the diameters of the raindrops. A full investigation of the phenomena will be found in Preston's "Theory of Light," Art. 301. Some interesting correspondence on the subject appeared in KNOWLEDGE for December, 1900, and February, 1901.—EDS.]

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

BLUE-TITS NESTING IN A PUMP.—A pair of Blue-Tits have for several years built about 15 inches down the inside of a pump here. Each time the handle is raised—and the pump is in constant use—the machinery works up through the nest without in the least disturbing the birds. The parent birds enter the pump by an aperture above the handle and leave it by one below.—WILLIAM CHARLES TETLEY, Aspley Guise, Beds.

RED-THROATED PIPIT (*Anthus cervinus*) IN IRELAND (*Zoologist*, July, 1901, pp. 264-267).—Mr. F. Coburn records that he obtained in Co. Mayo on May 26, 1895, a male specimen of this bird and that on August 9, 1898, Mr. H. Elliott Howard obtained a further specimen in Co. Donegal. It is a pity that the occurrences were not recorded before but Mr. Coburn gives his reasons at some length for having omitted to do so. The skins have now been identified by Mr. Aplin, and the occurrence, evidently on migration, of the Red-throated Pipit in Ireland may be taken as authentic. The bird has seldom been observed in Great Britain, and never before in Ireland. That this pipit is so rare a visitor to the British Islands as the records signify is, however, doubtful, since the bird has a wide breeding range in the far north and pushes its migrations in winter to Southern China, India, Persia, and the Nile. Although the normal lines of its migrations do not probably reach westwards of Heligoland, so small a bird undertaking such long journeys must often stray slightly from its course and reach Great Britain, where its great resemblance to the Meadow Pipit has undoubtedly caused it to be overlooked.

The Occurrence of the Black Kite (*Milvus migrans*) at Aberdeen.—Although a regular summer visitor to many parts of the Continent at no great distance from our coasts, the Black Kite has only once hitherto been observed in the British Islands. This specimen, recorded by the late Mr. John Hancock, as far back as 1867, was taken in Northumberland. Mr. George Sim now records that a male bird of the Black Kite was shot near the City of Aberdeen on April 16, 1901. (*Annals of Scott. Nat. Hist.*, July, 1901, p. 133.) That the bird has not visited this country more often is remarkable because, unlike the Red Kite, which was once so common a resident in England, the Black Kite, as its specific name *migrans* implies, is a migratory species.

Coues Redpoll (Linota rostrata) in Barra, Outer Hebrides (*Annals of Scott. Nat. Hist.*, *July*, 1901, pp. 131-133).—A study of the various races or subspecies of the Mealy Redpoll would be of interest and value to every British ornithologist in assisting to discover the origin of the Mealy Redpolls which visit our islands. Mr. W. Eagle Clarke has lately obtained some specimens of the Mealy Redpoll from Mr. W. L. MacGillivray in Barra. These birds Mr. Clarke proclaims to be of the Greenland form originally described by Dr. Coues as *Ægiothus rostratus*. Dr. Stejneger, whose conclusions regarding the Mealy Redpolls are now generally accepted, gave this race sub-specific rank under the title of *Acanthis linaria rostrata*. Mr Clarke prefers to employ the more usual generic name *Linota*, and to call the bird *Linota rostrata*. In any case whatever name is used, the form is a well-marked one, and is a native of Greenland and North-eastern North America. Its occurrence in Barra is of great interest, since it has never before been detected in Great Britain, although it has occurred as a rare straggler on the west coast of Ireland.

Wigeon Breeding in Ireland (*Zoologist*, July, 1901, p. 269).—Although the Wigeon has long been suspected of breeding in Ireland, its nest and eggs have not hitherto been discovered there. Mr. John Cottney now records the finding of several nests and eggs in Co. Down. Mr. Usher, the well-known Irish ornithologist, has identified both the eggs and the birds' down as those of genuine Wigeon. Surely it is an "injustice" that this record, as well as that of the Red-throated Pipit referred to above, were not first published in the columns of our deserving contemporary the *Irish Naturalist*, which is devoted to the study of the natural history of Ireland.

Supposed Breeding of the Honey Buzzard in Somerset.—In a letter to the *Ibis* (July, 1901, p. 515), Mr. W. Percival Westell records that Mr. Charles E. Nipper found the nests in May, 1897, and May, 1899, in Somersetshire, of birds which were recognised as Honey Buzzards. One nest was half-way down a precipitous cliff, and the other amongst some boulders on the ground. Each nest contained four eggs. Mr. Westell would have done well by giving more particulars in recording these extraordinary finds. The Honey Buzzard exceedingly rarely breeds in Great Britain now, and it is doubtful if it has ever bred so far west as Somersetshire. Two or three eggs form the usual clutch, four being very rarely laid. I can find no recorded instance of the Honey Buzzard breeding elsewhere than in a tree, the nest being usually placed from 25 to 50 feet from the ground. Mr. Westell will doubtless favour us with further details regarding these finds.

Dotterels in Wales (*Ibis*, July, 1901, p. 517).—Mr. O. V. Aplin on May 10th last watched four Dotterels (*Eudromias morinellus*) on a mountain in Merionethshire. Although fairly widely spread during migration in other parts of Great Britain, the Dotterel is of infrequent occurrence in Wales.

The Birds of Surrey.—Under the title "Ornithological Notes from Surrey" (*Zoologist*, July, 1901, pp. 247-254), Mr. J. A. Bucknill makes additions, more of which are promised, to his admittedly incomplete work, "The Birds of Surrey," published in 1900.

Bird-migration in the Riviera.—Under the title "On the Ornithology of the Var and the adjacent Districts," Mr. J. H. Gurney publishes an article in the *Ibis* for July, 1901, which will be of considerable interest to students of the migratory movements of British birds.

Ivory Gull in Northamptonshire (*Ibis*, July, 1901, p. 517).—Mr. O. V. Aplin writes to the *Ibis* that an immature specimen of the Ivory Gull (*Pagophila eburnea*)—a truly Arctic Gull and an occasional straggler to Great Britain—was shot at Weston-by-Weedon, Northamptonshire, on February 7th, 1901.

Little Bustard in Derbyshire (*Zoologist*, July, 1901, p. 270).—Mr. W. Storrs Fox records that a female specimen of the Little Bustard—an occasional visitor to the British Isles, and usually occurring in the colder months and in the southern and eastern counties—was shot by a farmer near Youlgreave, in Derbyshire, on May 14th, 1901.

Report on the Movements and Occurrence of Birds in Scotland during 1900. By T. G. Laidlaw, M.B.O.U. (*Annals of Scott. Nat. Hist.*, April and July, 1901, pp. 67-79 and 134-145).—Mr. Laidlaw's annual contribution on this subject to our contemporary will be found of much value to students of migration.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 10, St. Germans Place, Blackheath, Kent.*

Notices of Books.

"Annual Report of the Smithsonian Institution for the Year ending June 30th, 1898." Pp. lvi., 713. (Washington Government Printing Office. 1899.) Illustrated.—Though the Smithsonian Report does not reach British periodicals until some years after the date to which it refers, it is always welcome on account of the collection of scientific papers given in the appendix to it. Only one hundred pages of the present report are concerned with the affairs of the Smithsonian Institution; the remaining pages are taken up with reprints and translations of important papers on scientific subjects published in 1898 in various periodicals. These papers are accompanied by numerous plates and text illustrations, and they give a comprehensive view of scientific thought and expression in the year covered by the report. All matters of wide scientific importance form, at one time or another, the subjects of discourses or semi-popular descriptions by leaders of science, hence it is possible to refer to the Smithsonian Reports for authoritative statements on almost every subject which has engaged the attention of the scientific world. The translations will be of exceptional value to students who do not read foreign languages with facility.

"Papers on Mechanical and Physical Subjects." By Prof. Osborne Reynolds, F.R.S. Vol. II. Illustrated. (Cambridge University Press. 1901.) 21s. net.—By the publication of the papers in this and the previous volume, the Cambridge University Press is exercising its proper functions. The collected papers of men whose contributions to the advancement of knowledge are of permanent value may not appeal to a large public, yet great service is done to present and future investigators when the papers are brought together in a form convenient for reference. Prof. Osborne Reynolds's papers belong very decidedly to the scientific literature deserving preservation. The earlier volume included forty papers, and the present one brings the number up to sixty-seven, the years in which the papers appeared extending from 1881 to 1899. It is impossible here to describe the many subjects dealt with in these papers, but we can give reasons for our appreciation of them. In the first place, Prof. Osborne has a style of composition which many scientific men would do well to emulate. He does not write for children, or preach down to an uninitiated public, but practically everything he describes is presented in the simplest terms that the subject will permit. Another sign of Prof. Reynolds's genius is that subjects which he took up years ago have suggested lines of work to other experimenters. For instance, the resistance to the suction of water in pipes, and the study of fluid motion by means of coloured bands, formed the subjects of detailed papers by him in 1883 and 1895 respectively; and it is worth while to read these papers in connection with later ones by other authors on related subjects. Another instance is the long report on experiments made to determine the action of waves and currents on the beds and foreshores of estuaries by means of working models. As an example of a scientific investigation, carried on with all the refinements of modern methods, we may mention the determination of the mechanical equivalent of heat, described in the Bakerian lecture of the Royal Society in 1897. These are only rough indications of the contents of the volume, but as "good wine needs no bush," so Prof. Reynolds's work does not require advertisement in the scientific world. It will live to please and inspire generations of students of science.

"THE CROCODILIANS, LIZARDS, AND SNAKES OF NORTH AMERICA." By Prof. E. D. Cope. Pp 1294. Plates 36. (Washington: U.S. National Museum. 1900.) This posthumous work of Prof. Cope forms practically the whole of the Report of the U.S. National Museum for 1898, and is an important monograph on the scaled reptiles of North America. The geographical scope is the Nearctic geological realm, and the work constitutes the first general account of the North American Sauria or Lacertilia since that of Holbrook in 1845, and the only one on the Ophidia since the book of Baird and Girard, published in 1853. With the exception of a few pages the present memoir is naturally taken up with the lizards and snakes of these groups, which are with sufficient justification arranged in one order—Squamata. Taking the lizards as a centre, it is suggested that three series can be distinguished proceeding from the multiplicity of forms exhibited by them—namely, one towards the serpents by the subterranean lizard, Amphisbæna, found in the warmer parts of South America, one to the partially degraded type of the Geckos, and lastly through the highest series to Chamæleons. This relationship, however, is open to objections, and is not likely to be approved by all herpetologists. The order Loricata, including alligators and crocodiles, appeared in Triassic time, and has continued up to the present day. The genus Alligator is, however, of much more modern origin than Crocodilus, no undoubted extinct species having been discovered. The *Alligator mississippiensis* is the only species found in North America, one of the two other species of the genus occurring in China, while the habitat of the third is unknown. It appears that the alligators of North America cannot long escape extermination, and that the price of hides has gone up on account of the scarcity of the reptiles. The only crocodile described is *Crocodilus americanus*, though, unlike alligators, crocodiles are found in Africa, Southern Asia, and North Australia. The crocodile also differs from the alligator in its preference for salt water, and in being more vicious.

"THE USE OF WORDS IN REASONING." By Alfred Sidgwick. (A. & C. Black.) 7s. 6d. net. -A little logic is a dangerous thing, especially if it is the scholastic form of logic which is obscured with formalities. Opposition to this formal logic is one characteristic of Mr. Sidgwick's book; and there is no doubt that his objections require consideration from the schoolmen. Logic as often studied for examinational purposes is itself illogical; for it involves the acceptance of definitions and doctrines which do not admit of rigid proof. This, however, is a failing of text-books of other subjects. What Mr Sidgwick urges is that logic resembles the natural sciences in being progressive and full of problems only partly solved; and that the student should recognise this in taking up the subject. In other words, the student of logic should from the commencement be encouraged to view the subject in an inquiring frame of mind, even as he would such subjects as physics and chemistry in schools, where the "heuristic" method was followed. We are, of course, in sympathy with Mr. Sidgwick's aims, but at the same time we must remark that, like other logicians, he seems to labour much that it obvious to the ordinary person.

"TWENTIETH CENTURY INVENTIONS A FORECAST." By George Sutherland, M.A. (Longmans.) 4s. 6d. net.—Man, it is often said, is distinguished from all other mammalian vertebrates by his power of looking before and after. Nothing is more fascinating than to compare the present conditions of life with those of former times, and it is natural that after such retrospective glances the mind should proceed unconsciously to state a simple proportion: if during the last hundred years the world has seen such and such advances, what may be expected, taking the same rate of progression for granted, during the twentieth century? And what are the signs of the coming of these improvements destined to revolutionise human relations? Such is, expressed in its simplest terms, the problem which Mr Sutherland sets himself to solve. But, unfortunately for the correctness of their results, there is a disturbing factor in the computation, which these prophets are apt to ignore. In passing from the known to the unknown in a diagnosis of the future it is beyond human power to allow for the unexpected, yet the unforeseen discovery has taken the most important part in nineteenth century advances. The most far-seeing man of science, with an unequalled endowment in the way of scientific imagination, trying in 1801 to probe the mysteries of the future corld not have foreseen, for instance, even "through a glass darkly," the development of spectrum analysis in astronomy. So that the prophet is doomed to partial failure. There is, however, much useful work left for him, and this possible task of indicating the probable direction of the earlier improvements of the twentieth century has been attempted with much skill and considerable success by Mr. Sutherland. From the point of view of an ordinary cultured reader, with no knowledge of a technical kind, the author has indulged, perhaps, too much in detail, especially in the first two or three chapters, in which the sources and storage of natural and artificial power are examined. In some other sections, on the other hand, data are provided sufficient for the justification of several delightful glimpses of, to name an example or two, life at sea and the home circle in fifty years' time. His intimate knowledge of the inventions and discoveries of the last century has enabled the author to produce an entertaining book which should soon have a large number of interested readers.

"THE MICROSCOPE AND ITS REVELATIONS." Eighth Edition. (Carpenter.) Edited by the Rev. W. H. Dallinger, D.SC., D.C.L., LL.D., F.R.S., etc. 817 illustrations in the text, 25 plates, 1136 pages. 8vo, cloth, 28s.; half calf, 32s. (J. & A. Churchill.)—The appearance of a new edition of this standard work on the microscope and its many branches is particularly welcome, for it enables a comprehensive survey to be made of the progress that has been effected during the last few years in both optical and mechanical departments, and indicates the pressure that modern research has brought to bear on manufacturers, causing them to do their utmost to satisfy the needs of workers. In a former edition of this work—the seventh—the editor, the Rev. W. H. Dallinger, condemned in no uncertain language, the microscope known as the Continental Model; and laid down broad but sensible lines for the building of the stand that was to meet the demands of the various workers of the future. It was in that edition also that a strong plea was urged on behalf of the condensers having large aplanatic apertures and for increased accuracy in manipulation generally. A reference to the new edition of the work shows how accurate were the author's opinions and recommendations, and they were undoubtedly no inconsiderable factor in the general improvement that has since taken place in the design, and accuracy of action, of the best microscopes of to-day. This is revealed in the pages of the new volume, for many of the microscopes therein figured and described as types have been designed since the last edition was published, and owe their origin in some measure to the strong expressions of opinion then made. The present volume gives a clear exposition of knowledge and theory regarding the microscope; and although much of the text is to be found in the former edition, there are many new and re-written portions which add to the value and lucidity of the book. The reviews of the products of the various opticians are generous and fair, and will be found useful to those who need advice in the choice of apparatus. It is a matter for regret that the publishers have not seen their way to issue the book in two volumes—one devoted to the microscope and its optical fittings, and the other to the various branches of research with which it is associated. Many workers would require only the first part, while the second would appeal to general readers as much as to microscopists. In its present form it is rather a bulky book, especially for those who are resident abroad or travel with their microscopes. A little error concerning cover glasses has been perpetuated in the new volume, page 439. Not only are the thicknesses given for the three grades of cover glasses less than can be regularly obtained, but the thinnest covers are universally known as No. 1, the medium as No. 2, and the thick as No. 3, whereas the reverse order is there given. Also the price of a $\frac{1}{6}$ in. .82 N.A objective on page 374 given as £5 should be 50s. The book is well printed, the illustrations carefully prepared and well displayed, and the book is one that will be found invaluable as a text book to all microscopists.

"DISEASE IN PLANTS." By H. Marshall Ward, SC.D., F.R.S., etc. (Macmillan.) 7s. 6d. Prof. Marshall Ward has given us a useful and practical study of the general life of plants, and the causes and effects of the various forms of disease to which they are subject. The book is written essentially with the view of helping the cultivator—whether forester, vine-grower, or grower of roots or cereals—to understand the general facts of plant life, the relation of plants to their environment, and the nature and symptoms of the various maladies to which they [illegible] emphasis [illegible] subsidiary [illegible] portion of the work is devoted to [illegible] is treated historically [illegible] important subject of roots and rootlets is treated at some length, with a chapter on the characters of [illegible] of hybridisation and selection. [illegible] part of the book is devoted to the [illegible] with an interesting [illegible] subject. As to the causes of disease [illegible] very complex problems are [illegible] works alone [illegible] study of attendant conditions [illegible] conclusions. The various forms [illegible] briefly gone through. In the final chapter [illegible] consideration of plant [illegible]. The book will furnish a very useful introduction to the study of plant diseases, [illegible] so written that it can be read with interest by [illegible] of plant growers who do not profess any special [illegible] knowledge.

"The Mediterranean Race: A Study of the Origin of European Peoples." By G. Sergi, Professor of Anthropology in the University of Rome. Illustrated. [illegible] (London: Walter Scott, Paternoster Square. 1901.) Students of ethnology will welcome this work, the latest volume of the Contemporary Science Series, as a valuable contribution to our knowledge of the origin of primitive European civilizations. Professor Sergi's well-known researches have [illegible] been published in Italy in 1895, and in Germany in [illegible]. In the English edition now before us the author has carefully revised the results of his earlier works, and has added to them some valuable data bearing on the origin of the [illegible] races of these islands. The work has many excellent [illegible]. The facts are well marshalled, the exposition of current views on the subject are simple and direct, and the problems are clearly and cogently stated.

In the opening chapters the theories in vogue relating to the various phases of Indo-Germanism are dealt with. These are stated impartially, but each is finally subjected to a destructive analysis. The author attacks, in particular, the orthodox theories relating to the ancient conception of an Aryan civilization, and concludes by proving that the Neolithic races of Europe originated in Africa, and that the Mediterranean basin was the great centre whence the African migrants reached the centre and north of Europe. The main argument of the book is that from the great African stock, which he calls Eurafrican, originated the three varieties of people who inhabit Europe and Africa at the present day, viz., the African variety, the Mediterranean variety and the Nordic or North European variety. He does not dispute the Aryan invasion of Europe, but contends that the Aryan invaders were savages, and that they destroyed the superior civilization which the Eurafrican peoples had introduced. From this the conclusion is drawn that the Greco-Latin civilization is not Aryan, as is commonly supposed, but that it was a product of the Mediterranean species of the Eurafrican stock.

The additions that have been recently been made to our knowledge of the subject by archæological research in Cyprus, Sardinia, and Sicily do not, in our opinion, receive that attention at the hands of the author which their importance merits. The interesting discoveries that have been made during recent years in the Maltese Islands might, too, have received some mention. These islands have played a most important part in the migrations of the prehistoric Mediterranean races to and from Europe and Africa, and much valuable evidence of this has been forthcoming from the caves and [illegible] deposits of both Malta and Gozo. The megalithic ruins, too, of Hagiar Chim and Mnaidra, and the rock tombs that honeycomb the hillsides of the islands, are probably without rival in the Mediterranean, both for their admirable state of preservation and for the [illegible] collection of specimens of prehistoric art and of human remains that have been found within them.

Several chapters are devoted to the migrations of the Eurafrican peoples and to their struggles with the Eurasiatic races of whom the Aryans constituted a variety. From the [illegible] mingling which followed, the languages of the Eurafrican and the Eurasiatic became more or less transformed, and to this the author attributes the changes in the languages of Italy, Greece, and elsewhere, and the introduction of the Aryan element which is found in the Neo-Celtic of Wales.

The last chapter deals with the evolution of Mediterranean civilization, as shown by the architecture of the tombs and the culture, language and writing of the peoples of the area. The book contains much that is both novel and suggestive, and it is decidedly to be recommended.

BOOKS RECEIVED.

[illegible] By E. A. [illegible] (Longmans.) 7s. 6d.

[illegible] By E. [illegible] (Dent.) Illustrated.

Text-Book of Astronomy. By George C. Comstock. (Hirschfeld Brothers.) Illustrated. 7s. 6d.

Thermal Measurement of Energy. By E. H. Griffiths, M.A., F.R.S. (Cambridge University Press.) 2s.

[illegible] King of England. By A. [illegible] (Harrison and Sons.) 2s. 6d.

The Photo-Miniature. June, 1901. (Dawbarn & Ward.) [illegible]

Gesso Work. By Matthew Webb. (Dawbarn & Ward.) [illegible]

Terrestrial Magnetism and Atmospheric Electricity. [illegible] 1901. (Wesley.) 75 cents.

Catalogue Astrophotographique Internationale. [illegible] 1900. (Paris: Gauthier-Villars.)

Reports on the Administration of Rhodesia, 1898-1900. (The British South Africa Co.)

Irish Topographical Botany. By R. Lloyd Praeger, B.A., B.E., M.R.I.A. (Dublin: The Academy House.) 10s. 6d.

Obituary.

ELEANOR A. ORMEROD.

British economic science has suffered a loss, irreparable for many years at least, by the death of Miss E. A. Ormerod, whose studies of insects in their relation to the work of the farmer, the forester, and the gardener, had brought her a world-wide reputation. She was born on May 11th, 1828, at Sedbury, Gloucestershire, a daughter of Dr. Geo. Ormerod, known in his day as historian of Cheshire. Living a quiet country life at Sedbury, at Tildesley, at Isleworth, and finally at St. Albans, she constantly occupied herself with observations on plants and insects, and following in the footsteps of Curtis, Westwood, and Riley, came to occupy an unique position as an authority on economic entomology. Her advice, freely given to practical men all over the country, involved her in a laborious correspondence, and the information thus elicited was incorporated in her "Reports on Observations of Injurious Insects," which, commencing in 1877, were issued yearly until 1900. An intimation in last year's Report that failing health would prevent the issue of any more, has been followed all too soon by her death, which took place on July 19th at her home in St. Albans. In addition to the Reports she published several valuable books, including "A Manual of Injurious Insects," "A Text-book of Agricultural Entomology," and "A Handbook of Insects Injurious to Orchard and Bush Fruits." Her life-work was greatly helped by her elder sister, Georgiana, whose death in 1896 she felt deeply. For several years she acted as Consulting Entomologist to the Royal Agricultural Society, and she was examiner in agricultural entomology to Edinburgh University, of which she was the first-made female LL.D., an honour only conferred a year before her death. Miss Ormerod won the confidence of farmers and gardeners both by the painstaking thoroughness of her work and by the business-like nature of her suggestions. Herself a skilful gardener, she never lost sight of the question whether a certain remedy would be practicable and profitable if employed on a large scale. Hence as an exponent of applied science she succeeded better than others whose scientific training and methods may have been more modern than her own. Her caution is well shown by her reluctance to follow American practice in recommending such powerful poisons as copper arsenite or carbon bisulphide as insect-killers. She has well served her day and generation. May her work be carried on by those whom she has so generously cheered and encouraged by advice and example.—G. H. C.

SIR CUTHBERT E. PEEK, BART., M.A., F.S.A., ETC.

It is with deep regret that we have to record the death of so liberal a patron of science as Sir Cuthbert Peek, who died at Brighton on July 6th. He was the only child of Sir Henry, the first Baronet; was born in 1855, and married in 1884 the Hon. Augusta Louisa Brodrick, daughter of the eighth Viscount Midleton, and only succeeded his father in 1898. He was educated at Eton and Pembroke College, Cambridge, was J.P. for Devon, Middlesex, and London. From early years he was interested in many branches of science and distinguished himself as an active worker in astronomy and meteorology, was a fellow of the Royal Astronomical, Geographical, and Meteorological Societies, of the Society of Antiquaries and of the Anthropological Institute, and served on various councils of the learned societies. He went to Australia in 1882 to observe the transit of Venus, and on his return he drew up the plans for the Rousdon Observatory near Lyme Regis, South Devon, which was built in 1884. Part of his equipment was a 6.4 Merz equatorial telescope, which has been in use since 1885, in his well-known study of long period variable stars. From the observatory, Greenwich mean time was furnished to the district. In addition to astronomical work, he also devoted himself to meteorology, and the annual reports from the observatory were rich in scientific information. In addition to the usual meteorological observations, he made somewhat of a speciality of instruments connected with rainfall and wind velocities, having a registering pluviometer and evaporation tanks, whilst a latticed tower for carrying the anemometers is a conspicuous object of the neighbourhood. Some years ago he conducted a series of experiments for the purpose of determining the factor for getting the true wind velocity from the Robinson cup anemometer, and eventually adopted the Dines pressure-tube instrument as the standard. It was with this latter instrument that he recorded the highest wind velocity ever registered in England during a gale in 1897. Sir Cuthbert was not so keen an ornithologist as his father, but nevertheless he had kept in a good state of preservation the collection of British birds that Sir Henry had made; whilst a never-failing source of interest to the visitor at Rousdon was the ethnographical museum which he had formed. Science indeed is bereaved by the loss of one who had its interests so near at heart.

NOTES

ASTRONOMICAL.—Additional interest has been given to the well-known "Runaway Star," 1830 Groombridge, by the recent spectroscopic determination of its velocity in the line of sight which has been undertaken by Prof. Campbell at the Lick Observatory. It results from the observations that the star is approaching the sun with a velocity of 59 miles per second, which is much less than the probable velocity of about 150 miles per second with which the star moves across the line of sight. The observations are of special importance as demonstrating the possibility of measuring the velocities of stars as faint as the 8th or 9th magnitude, provided that their spectra contain well-defined lines.

Recent investigations of the spectroscopic binary Mizar (Zeta Ursae Majoris) which have been made at Potsdam indicate that the period is probably 20.6 days, and not 104 days as previously deduced at Harvard. Prof. Vogel further finds that the eccentricity of the orbit is 0.502, and the maximum relative velocities in the line of sight 128 and 156 kilometres per second. The system is approaching with a velocity of 16 kilometres per second.

A list of 59 "objects having peculiar spectra," given by Prof. Pickering in Harvard Circular No. 60, is of special interest, as 28 of the objects are included in the Large Magellanic Cloud. Of these, 10 are gaseous nebulæ, 15 are stars of the Wolf-Rayet type, and 3 are stars of the first type with some of the hydrogen lines bright; it will thus be seen that the cloud not only resembles the Milky Way in general appearance, but is also rich in types which specially frequent the Milky Way. Among other objects described, five are of great importance as having spectra resembling those of the Wolf-Rayet stars, but with the lines dark upon a continuous background.

Owing to the unavoidable delay in Mr. E. W. Maunder's return to England, the Constellation Study which should have appeared in this number of KNOWLEDGE has to be omitted.—A. F.

BOTANICAL.—The *Revue Horticole* for July 16 contains a paragraph respecting the experiments carried on under the auspices of the Imperial Society of Horticulture of St. Petersburg with the view to determine the length of time during which the pollen of various plants will retain its vitality. It is shown that the rose can be fertilised with pollen 22 days old, and species of *Clivia* when it is 3 months old; further, a case is cited where the pollen of some hybrid Clivias had not lost all its vitality after being collected a year. In a later number of the *Revue*, Monsieur Mangin draws attention to his researches into the subject published in the *Bulletin de la Société botanique de France*, Vol. XXXIII., and gives a short list of plants with the length of time that the pollen retains its germinative power in each case. While the pollen of the common wood-sorrel (*Oxalis acetosella*) may be preserved for one day only, that of the *Narcissus* proved capable of growth for 80 days. Monsieur Mangin observes that the vitality of the pollen is relatively short in plants which flower for a long time.

In many tropical countries attention is now being paid to the commercial prospects of the leaves of the coffee-tree as a substitute for those of the true tea-plant in the preparation of tea. The natives of Sumatra, where the coffee-tree abounds, use a beverage made from its leaves in preference to that obtained from the berries, which, in consequence, are allowed to fall to the ground and decay. When grown for its berries, the coffee-tree will succeed only in certain soils and situations, whereas an abundance of foliage suitable for making coffee-leaf tea may be produced on almost any fertile soil. A chemical analysis shows that the leaf contains all the characteristic properties of the berry, but is richer in theine. The editor of the *Queensland Agricultural Journal*, in which some interesting notes on the subject have been published, declares the coffee-leaf tea to be a pleasant and refreshing beverage.—S. A. S.

Zoological. — For some time Dr. G. L. Johnson has been engaged in studying the internal structure of the eyes of mammals under the ophthalmoscope, and the results of his investigation, illustrated by thirty coloured plates, have been published in the *Phil. Trans.* Great variation in the arrangement of the blood-vessels, as well as in the colour of the retinae are noticeable; blue and violet seem to be unknown, while red, yellow, and green form the predominating shades. In the main, the various types of minute ocular structure correspond very closely with the different groups into which mammals are now divided; this correspondence affording important testimony in favour of the general correctness of our scheme of classification. Among the exceptions are the South American squirrel-monkeys, whose eyes approximate in structure to those of the lemurs. In regard to the range of vision possessed by different animals it is mentioned that man and monkeys alone possess parallel and convergent vision of the two eyes. On the other hand, divergent and consequently very widely extended vision is a prerogative of the lower mammals; squirrels, for instance, and probably also hares and rabbits, being able to see an object approaching them directly from behind without the necessity of turning their heads.

A most remarkable discovery has recently been made with regard to the earliest and most primitive whale — the extinct *Zeuglodon*. In association with the remains of this creature have been discovered on more than one occasion solid bony plates, which have been regarded as forming the dermal armour of a turtle. It is now, however, demonstrated that the plates in question belong to *Zeuglodon* itself, which appears to have had dermal armour on the back-fin and certain portions of the back somewhat resembling that of the South American glyptodont armadillos. Traces of a similar armour occur in an extinct Croatian dolphin, and tubercles found on the back-fin of the common porpoise and on the back of the Japanese *Neophocaena* may doubtless be regarded as the last remnants of this structure. As a partial armour would be useless, it may be assumed that the ancestral cetaceans were fully protected by bony plates. But such a rigid panoply would obviously be unsuitable to a pelagic type, such as *Zeuglodon* seems to have been, and it is accordingly presumed that the armour was restricted to part of the back of that animal. The presumption that the ancestral cetaceans were fully armoured must not, however, be taken to indicate that they were descended from mail-clad land animals. On the contrary, they themselves developed the armour, which may have been for the purpose of protecting them from the breakers and the attacks of sharks when they led an amphibious life on the coasts. These interesting investigations are by Dr. O. Abel, and appear in a recent issue of the *Beiträge zur Paläontologie und Geologie Österreich-Ungarns*.

It was recently stated in an official report that salmon do not feed while in fresh water, being afflicted during their sojourn in rivers with a disease of the lining membrane of the alimentary tract. Later observations discredit the correctness of this view, evidence having been adduced that river salmon catch and digest minnows and other fish. The presumed disease of the lining of the stomach is stated to be owing to the fact that the fish examined were not sufficiently fresh. Still, the fact is not disputed that during the time spent in fresh water salmon maintain themselves to a very considerable extent on the store of fat accumulated in their tissues during their marine life.

In *The Geographical Journal* of August 3rd appears an excellent figure of the head and neck of a presumed new type of giraffe obtained by Sir Harry Johnston in north-east Uganda. In addition to an apparently distinct type of coloration the male of this giraffe possesses a pair of low prominences behind the large horns, so that it is called by its discoverer five-horned. The same issue of the Journal contains a coloured illustration of the new mammal, the Okapi (*Okapia johnstoni*).

Much interest attaches to an article on mother-of-pearl oysters, by Dr. H. L. Jameson, which appears in the August issue of the *Proceedings* of the Zoological Society. The enquiry has been based on the large series of these shells in the collection of the British Museum, and its inception was suggested by Professor Ray Lankester. Perhaps the most remarkable circumstance connected with the investigation is the discovery that the large Austro-Malayan oyster, the valuable "silver-lip" and "gold-lip" of commerce, is a distinct and hitherto unnamed species. For this form the name *Margaritifera maxima* is appropriately suggested.

Another important item in the same journal is a memoir by Dr. A. Smith Woodward on extinct reptiles from Patagonia. The forms described include a tortoise belonging to the genus *Miolania*, hitherto known only from the Pleistocene of Australia; a large snake closely allied to an existing South American type, and a carnivorous dinosaur related to the European *Megalosaurus* and the North American *Ceratosaurus*. The two questions of most general interest discussed in this communication relate to the apparent mixture of types elsewhere characteristic of widely separated geological horizons in Patagonia, and to the conclusions to be drawn from the occurrence of closely allied forms in the Australian and Patagonian Tertiaries. As regards the former point it seems either that dinosaurs survived in South America into the mammalian period, or that some confusion has been made between the reptiliferous and mammaliferous beds. As regards the latter, it is suggested that the tortoise may have reached the one hemisphere from the other by way of the Antarctic continent. On the other hand, "it is just possible that, if the direct ancestors of *Miolania* were known, this remarkable chelonian would prove to have originated not on any old Antarctic continent, but in some other region of the globe from which scattered survivors wandered into the lands now named South America and Australia respectively."

CURRENT CARCINOLOGY.

By the Rev. T. R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S.

In the olden time the history of nature was written at less length and with less continuity than at present. Like the "resting-eggs" of Entomostraca, subjects were allowed to have a period of quiescence, of peaceful oblivion before hatching out into new activity. We moderns have changed all that. Be the subject what it may, the discussion of it flows on without ceasing. No one steadily watching that flow would expect it to fail and be cut off. Nevertheless, like the stripling who "in a showerful spring stared at the pate," a novice suddenly confronted with all that has recently been published on the class of crustacea might well give a gasp of surprise. For this, as for other classes of the animal kingdom, there are various records which keep the student informed as to the titles and the contents of the specialist literature. It is not, perhaps generally understood how much skill and learning and industry are brought to bear upon the compiling of these records. In regard to the fame, the money, and the thanks to be won by such work, there is little of the first, less of the second, and, one might almost say, nothing at all when you come to the third. For the essential service rendered it is no one's business to reward the compilers. On the contrary, the infuriated student is inclined to turn again and rend them, because they do not supply him with money to buy or time to read or the gift of tongues to understand the interminable series of books and pamphlets of which they make him guiltily conscious. It is not the intention of this chapter, then, to compete with these unhappy recorders. Its purpose is rather to show the general reader how large a share in scientific literature is being claimed and how many avenues of research are opened by a subject so modestly attractive, so engagingly unpretentious as carcinology.

This branch of science can no longer be regarded as unfashionable or neglected. Be it by king or prince or republic, by university, museum, or private enterprise, active and generous help is given for its promotion, enlightened interest displayed, knowledge of it largely and rapidly extended. In point of fact, though the picking up of a little crab from the bottom of the ocean may be scoffed at as an insignificant feat, deep-sea exploration, by whomsoever carried out, is royally expensive. The effort lies idle until the results are published. The animals brought to light must be described and figured, and the costliness of adequate illustrations is far higher than the inexperienced would suppose. It should, however, be remembered that the accurate and full delineation of natural objects is a marvellous boon, not only to those living at the time of the discovery, but to a long series of subsequent students. It is a poor jest to ask a riddle to which there is no answer, but that is just like the dull mischief of introducing a new species ill described or half described, carelessly figured or not figured at all. Not seldom the consequence is that for ages afterwards naturalists are worried with the fleeting hope of recognising the unrecognizable. Fortunately the fine books which have lately appeared on various branches of carcinology are armed against any such reproach. It is evident that no pains or expense have been spared to make them satisfy the demands of modern science. The preparation has, in some instances, necessarily been spread over many years. In some cases the materials with which the reports are concerned were obtained by expeditions of comparatively distant date. Thus the decapod crustaceans described by Milne-Edwards and Bouvier for the French Government were collected by the exploring vessels, the "Travailleur" and the "Talisman," in the four successive years from 1880 to 1883.* In another work they deal with the same group from the scientific campaigns of the Prince of Monaco on board the "Hirondelle" and the "Princesse Alice."† In still earlier cruises of the "Hirondelle" the same enthusiastic navigator procured the Amphipoda which are so admirably treated in M. Chevreux's learned and beautifully illustrated volume.‡ An important group of the Amphipoda, which are discussed in a fine memoir by Dr. Vosseler, are from among the extensive fruits of the well-known Plankton Expedition of 1889.§ A great work by Lilljeborg|| has a different kind of origin. It refers to small animals, almost all of which live in fresh water. For procuring them it is, as a rule, not necessary to commission a man-of-war nor to employ yachts fitted with costly apparatus and the latest devices of mechanical ingenuity. But procuring material and bestowing upon it all the tenderest care of pen and pencil will remain ineffectual unless the cost of publication can be defrayed. In this respect the veteran professor found his path smoothed by the King of Sweden and Norway and the Royal Society of Upsala. Others will join him in his grateful acknowledgments. It should not be forgotten that in the subject of this grand monograph Wilhelm Lilljeborg made his mark so long ago as 1853, and he now tells us that already in that distant time his ambition had conceived the project at length accomplished. His success in bringing out such a work at the age of eighty-four should rank among remarkable performances.

To the volume on the crustacea of the "Travailleur" and the "Talisman" a keenly personal interest also attaches. For three-quarters of a century important treatises on carcinology have issued at brief intervals from the pen of a Milne-Edwards. The famous father Henri lived to a very advanced age. The famous son Alphonse has not equalled him in length of days, although in rendering many and great services to zoology he has faithfully followed in his father's footsteps. On the special subject of crustacea he has for some years past been working with an invaluable ally, Professor E. L. Bouvier. Sad as it is to reflect that this collaboration has now been sundered by the unexpected death of Alphonse Milne-Edwards, at least it closes graciously with a work nobly becoming to the high reputation of both authors.

Another striking volume published last year from Professor Giard's zoological station at Wimereux will presently have to be mentioned, but neither France nor Sweden nor any other country can claim a monopoly of the subject. In Calcutta, Major Alcock is drawing to a conclusion his elaborate account of the crustacea obtained by the survey ship "Investigator."¶ The Cape Government has begun to publish its "Marine Investigations" on the same class.* Mr. Whitelegge, of

* "Expéditions Scientifiques du 'Travailleur' et du 'Talisman.'" Ouvrage publié sous les auspices du Ministère de l'Instruction Publique. Crustacés décapodes. Première partie. Brachyures et Anomoures. Par A. Milne-Edwards, Directeur du Muséum d'Histoire Naturelle, et E. L. Bouvier, Professeur au Muséum d'Histoire Naturelle. 4to, 396 pages, 32 plates, 7 coloured. (Paris, 1900.)

† "Résultats des Campagnes Scientifiques accomplies sur son Yacht." Par Albert Ier., Prince souverain de Monaco. Fascicule XIII. Crustacés décapodes provenant des campagnes de "l'Hirondelle" (Supplément), et de la "Princesse Alice" (1891–97). Par A. Milne-Edwards et E. L. Bouvier. 4to, 87 pages, 4 plates, 2 coloured. (Monaco, 1899.)

‡ "Résultats, etc." Fascicule XVI. Amphipodes provenant des campagnes de "l'Hirondelle" (1885–88). Par Ed. Chevreux. 4to, 195 pages, 18 plates, 1 coloured. (Monaco, 1900.)

§ "Die Amphipoden der Plankton-Expedition." Von Prof. Dr. J. Vosseler. I. Theil. Hyperiidea 1. 4to, 129 pages, 11 plates, 2 maps, 5 figures in the text. (Kiel and Leipzig, 1901.)

|| "Cladocera Sueciæ, oder Beiträge zur Kenntniss der in Schweden lebenden Krebsthiere von der Ordnung der Branchiopoden und der Unterordnung der Cladoceren." Von Wilhelm Lilljeborg, Professor emeritus. 4to, 701 pages, 87 plates. (Upsala, 1900.)

¶ "Illustrations of the Zoology of the Royal Indian Marine survey ship 'Investigator.'" Crustacea. Part VIII., plates 46-48, 4to. (Calcutta, 1900.)—An account of the deep-sea Brachyura collected by the Royal Indian Marine survey ship "Investigator." By A. Alcock, M.B., C.M.Z.S., F.G.S., Superintendent of the Indian, Professor of Zoology, etc. 4to. 85 pages, 4 plates. (Calcutta, 1899.)

* "Marine Investigations in South Africa." South African Crustacea. Part I., 8vo, 66 pages, 4 plates, 1 coloured. (Cape Town, 1900.)

the Australian Museum, has issued two parts of his "Crustacea" from the trawling expedition of H.M.C. "Thetis" off the coast of New South Wales.† Mr. L. A. Borradaile describes crustacea from Funafuti and Fiji.‡ Mr. W. F. Lanchester deals with a collection from Malacca and Singapore.§ Researches by Vallentin in the Falkland Isles, by Perkins at Hawaii, by Dr. Willey in the South Pacific, have yielded very interesting

Leptodora kindtii (Focke), commonly called *L. hyalina*. From Lilljeborg's *Cladocera Sueciæ*.

results. Dr. Calman describes Brachyura from Torres Straits, collected by Professor Haddon in 1888.¶ Professor Sars, besides concluding the third volume of his "Crustacea of Norway," has published an important essay on the Cladocera of South America.* From the United States come numerous contributions of much value and utility. Among these Miss Rathbun exhibits her commanding knowledge of crustacean lore in "Results of the Branner-Agassiz Expedition to Brazil," and in a paper on the decapod crustaceans of West Africa.** On the Asterocheridæ, a noteworthy group of the Copepoda, Dr. Giesbrecht publishes a scholarly monograph, charmingly illustrated after the fashion for which the biological station at Naples is justly celebrated.†

Besides the systematic works, ranging from thick quartos to thin pamphlets, there are other memoirs dealing with the subject from all sorts of expected and unexpected points of view. For instance, a short paper by Mr. E. A. Mearns records the exceptional dimensions of an American lobster,‡ a long one by Mr. F. C. Waite treats fully the structure and development of its antennal glands.§ Mr. G. H. Parker discusses "The photomechanical changes in the retinal pigment of Gammarus." Mr. S. J. Holmes also has an elaborate paper on "Phototaxis in the Amphipoda."¶ The same author publishes interesting observations "On the Habits and Natural History of *Amphithoe longimana* Smith."* One of his sections is on Thigmotaxis. Let not the reader be daunted. Thigmotaxis is nothing but a tendency to keep in contact with solid objects. We have it ourselves, however much swimmers, aeronauts, and spiritualists may endeavour to set it at defiance. Another section, "On the Effect of Cutting the Animal in Two," may for a moment shock the sensitive. But, as it appears that the swimming feet of the victim's hinder half "kept up their rhythmical beating for fully a half hour," and that its front half was still able to appropriate and devour food, we may hopefully infer that these creatures are not very painfully afflicted even by disastrous accidents. Like ourselves, they no doubt suffer from fear, to impel them to acts of self-preservation, but under the infliction of mortal injuries they have the happiness not to know how badly they are hurt.

Milne-Edwards and Bouvier lay great stress on their classification of the higher Malacostraca. From their point of view the Anomura are not to be regarded as a group intermediate between the Brachyura and Macrura. They hold, in accord with Boas, that lobster-like forms of the latter have given rise to two independent lines of evolution. The result may be briefly indicated by saying that in one line the Dromiacea, or primitive Brachyura, lead up to the genuine Brachyura, or crabs, properly so called; the other line runs out in the Anomura, with three principal branches, the Paguridea, including but not limited to the hermit-crabs, the lobster-like Galatheidea, embracing also the small, flattened, crab-like Porcellanidæ, and lastly the Hippidea. Since there are many in this line to which the term Anomura is by its meaning unsuitable, it would seem to be better to drop it altogether, adopting in place of it the expression Macrura anomala.

For one interesting genus of Galatheidæ the French authors persist in retaining the name *Diptychus*, although it was changed to *Uroptychus* by Dr. Henderson in his "Challenger" report, on the indisputable ground that *Diptychus* had been earlier used by Steindachner for a genus of fishes. They rely on the strange argument that perhaps Steindachner's generic

† "Memoirs of Australian Museum." Vol. 4, Pt. 2 pp. 175-199, plates 33-35, 1900, and Vol. 4, Pt. 3, pp. 203-246, figures in text, 1901.

‡ "Proc. Zool. Soc., London." pp. 568-596, plates 40-42, 1900.

§ "Proc. Zool. Soc., London." pp. 719-770, plates 44-47.

"Proc. Zool. Soc., London." pp. 517-568, plates 36-39, 1900; Fauna Havaiensis, Vol. 2, pp. 527-530, plate 21. 4to. (Cambridge, 1900); A. Willey's "Zoological Results." Part 5, pp. 605-690, plates 64-74. 4to. (Cambridge, 1900.)

¶ "Trans. Linn. Soc. London." Vol. 8, Part 1, pp. 1-50, plates 1-3. 4to. (London, 1900.)

* "An Account of the Crustacea of Norway." Vol. 3 Cumacea, parts 1-10, 115 pages, 72 plates, large 8vo. (Bergen, 1899-1900.) "Contributions to the knowledge of the fresh-water Entomostraca of South America, as shown by artificial hatching from dried material." By G. O. Sars. Part I.—Cladocera, with 12 autographic plates, 102 pages. (Kristiania, 1901.)

** "Proceedings of the Washington Academy of Sciences." Vol. 2, pp. 133-156, plate 8, 8vo. (Washington, 1900.) "Proceedings of the United States National Museum." Vol. 22, pp. 271-316. (Washington, 1900.)

† "Fauna und Flora des Golfes von Neapel und der angrenzenden Meeres-Abschnitte." 25. Monographie. Asterocheriden, von Dr. Wilhelm Giesbrecht. 4to, 217 pages, 11 double plates, 2 coloured. (Naples-Berlin, 1899.)

‡ "Proc. Biol. Soc., Washington." Vol. 13, pp. 168-9, 1900.

§ "Bulletin, Mus. Comp. Zoöl., Harvard." Vol. 35, pp. 151-210, 6 plates. (Cambridge, Mass., U.S.A. 1899.)

Loc. cit., pp. 143-8, 1 plate.

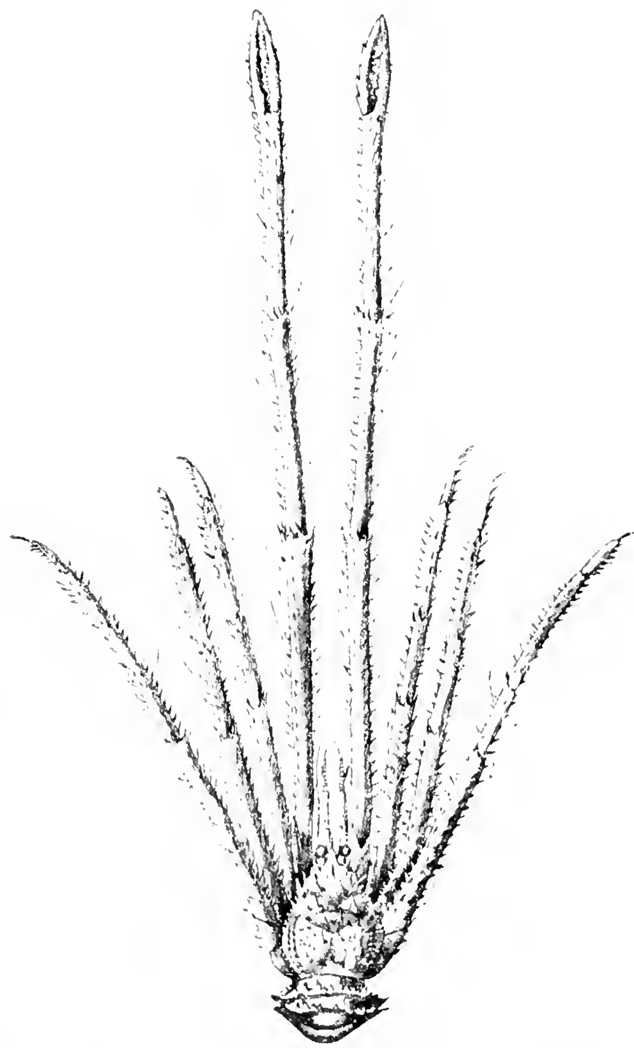
¶ "American Journal of Physiology." Vol. 5, pp. 211-234.

* "Biological Bulletin." Vol. 2, pp. 165-193. (Boston, U.S.A., 1901.)

name ought to be made a synonym of something else. Under the name of "*Munida Bamffica*, Pennant," they identify the "*Astacus Bamffius*, Pennant," 1777, with the "*Pagurus rugosus*, Fabricius," 1781, but in this they overlook the fact that Fabricius first described his species not in 1781 but in 1775, so that the proper title now is *Munida rugosa* (Fabricius). Absolute accuracy in names is a thing very difficult to attain. Miss Rathbun, who may be accounted our most learned authority on the subject, in her "Decapod Crustaceans of West Africa" assigns *Palinustus phoberus*, Rochebrune, 1883, to the genus *Palinostus*, Bate. This might seem a very natural thing to do, on the supposition that Rochebrune had accidentally mis-spelled the name. But, as a matter of fact, Bate's genus dates from 1888. It is itself a synonym of *Jasus*, Parker, 1883, but not of *Palinustus*, which was defined by A. Milne-Edwards in 1880. To what genus Rochebrune's species really belongs is none too certain. In the Entomostraca Professor Lilljeborg upholds the genus *Lynceus* and the family Lynceidæ as valid among the Cladocera. Now the truth is that O. F. Müller's genus *Lynceus* was restricted by Leach in 1816, who then distinguished *L. sphaericus* from *L. brachyurus* by placing the former in a new genus designated *Chydorus*. The consequence is that we have in the Cladocera a family Chydoridæ, while the phyllopod family Limnetidæ must assume the name Lynceidæ, since its single genus *Limnetis*, Lovén, includes Müller's *L. brachyurus*, and must therefore revert to the old generic name of *Lynceus*.

In the late William Stimpson it cannot be doubted that the United States possessed a carcinologist of great merit. But his papers are not always easy to meet with, and his descriptions of new species are often very brief and unaccompanied by figures. Thus his work has from time to time to undergo a process of rediscovery. Miss Rathbun in her Brazilian paper describes and figures a new species *Glypturus branneri*, the genus of which is nearly allied to *Callianassa*. This *Glypturus* was instituted by Stimpson, and has evidently long been overlooked till Miss Rathbun dredged it up from the deep sea of forgotten literature. Again, a very notable crustacean, *Hapalocarcinus marsupialis*, was briefly described by Stimpson in 1859. This, it is true, has not escaped the attention of subsequent observers, though they have been more concerned with its habits than its structure. Dr. Calman's paper in the Linnean Transactions is the first to bestow upon it accurate description and adequate illustration. It is not very awe-inspiring by its dimensions, the carapace being only about a tenth of an inch in length and in breadth. But though so small it is in more than one respect a great curiosity. It forms gall-like excrescences in corals, managing to keep open sufficient apertures for the ingress and egress of water, but otherwise allowing itself to be imprisoned by the growth of the coral around it. Since none but females have been found thus walled in, it is conjectured that both sexes are free till after marriage, and that then the females alone become completely domesticated, like the women in Lord Lytton's story of "The Coming Race," who under similar circumstances contentedly shed their wings. Another genus, *Cryptochirus*, Heller, furnishes a somewhat similar species of crabs parasitic on corals, and the two genera form Calman's family Hapalocarcinidæ. This, he decides, must be placed among the true Brachyura, although there are some perplexing resemblances to some of the anomalous Macrura.

The Cumacea (or Sympoda†), with which the admirable third volume of Sars's Crustacea of Norway is wholly concerned, have not as yet yielded any parasitic or commensal species, unless *Nannastacus unguiculatus*, Bate, found in the nest of the mollusc



Ptychogaster formosus (A. Milne-Edwards). A deep sea Galatheid. After E. L. Bouvier.

Lima hians, may be considered an exception. The Isopoda, on the other hand, have shown extreme partiality for the labour-saving expedient of living on their neighbours. M. Jules Bonnier devotes a large and valuable volume to that section of them which are commonly known as bopyrids.‡ These, in their attachment to other crustaceans, develop many eccentric forms. They pass through strange metamorphoses. One division exhibits the character, ever remarkable though not unique, by which the same individual is first a male and then a female. In another division, M. Bonnier inclines to believe that, while the larvæ are potentially of either sex, the one which first obtains a good

† For this change of name see Willey's "Zoological Results," Part 5, p. 609.

‡ "Contributions à l'étude des Epicarides les Bopyridæ." Par Jules Bonnier. Travaux de la Station Zoologique de Wimereux. Vol. 8, 4to, 396 pages, 41 plates, portrait. (Paris, 1900.)

nourishing situation develops into a female, that one of the others then becomes what he calls "a definitive male," the rest having either to bide their time for similar chances, or perhaps having to be content with the lot of Portia's unsuccessful suitors. One genus displays a kind of inverted Mormonism, a solitary female being privileged to have numerous mates strongly attached to her. Messieurs Caullery and Mesnil, writing on *Hemioniscus balani*, which is parasitic on cirripedes, note that this is the only crustacean genus yet known in which there are two oviducts on each side.§ The "Notes on some crustacean parasites of fishes" by Mr. Thomas Scott, F.L.S., ought not to be neglected.

Of Dr. Birula's papers on Russian Malacostraca it must suffice to say that though the crustaceans themselves are not confined to the dominions of the Czar, the discussion of them is, unfortunately for the monoglot Englishman, exclusively in Russian.•

The spirited essays in which the eminent Danish zoologist, Dr. H. J. Hansen, has been appealing to his countrymen to shake off political apathy, to cultivate a stedfast friendship with Great Britain, and to set their scientific household in order, would not come within the scope of this chapter, but for the remarkable appendix on "Rhizorhina, Herpyllobius, and Soren Jensen," which the student of Entomostraca ought not to overlook.*

Here the account of current carcinology might well have paused, had not the intention of stopping been frustrated by the coincident arrival of Major Alcock's "Descriptive Catalogue of the Indian deep sea Macrura and Anomala,"† and of a pleasant work by the same author, called "Zoological Gleanings from the Royal Indian Marine survey ship Investigator."‡ In contrast to the diminutive forms that nestle in corals, the following passage from the "Gleanings" shows us land-crustaceans holding their own in the struggle for existence even against vertebrates:—"On Pitti Bank, which is a little uninhabited sand-cay of one of the most submerged of the Laccadive atolls, we found, at the end of November, 1891, vast swarms of a large species of sea-tern breeding. There were nestlings in every stage, but no eggs. Both old and young birds were quite free from fear, the old birds almost alighting on our shoulders as we landed, and the young birds, even those with their first plumage complete, submitting to capture without any resistance. Dreadful havoc had been wrought among the young birds, chiefly by large Cœnobite hermit-crabs, with which the islet swarmed, but also to some extent by *Ocypoda ceratophthalma*. The young broods were simply huddled together on the ground, without any sort of nest, so that in the absence of the parents they were at the mercy of the crabs. Judging from the bones and sprouting quills that covered the ground, hundreds of young birds must have perished, and in several cases we saw recently killed bodies lying under a living mound of voracious crabs."

§ "Bulletin Scientifique de la France et de la Belgique." Vol. 34, pp. 316-362, plates 17-18. (Paris, 1901.)

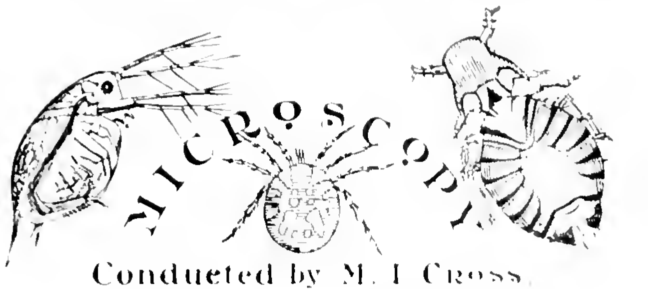
Fishery Board for Scotland. 18th Annual Report, pp. 144-188, plates 5-8. 1900.

• "Annuaire du Mus. Zool. Acad. Impériale des Sciences de St. Pétersbourg." 1899, 1900.

• "Danmarks Stilling og Tilstand." Af H. J. Hansen, Dr. Phil. Part 2, 216 pages. (Kjobenhavn, 1900.)

† 4to. 290 pages, 3 plates. (Calcutta, 1901.)

‡ Reprinted from the "Scientific Memoirs by Medical Officers of the Army, India." Part 12, pp. 35-76. 4to. (Simla, 1901.)



Conducted by M. I. Cross.

The Heliostat in Microscopy.—The microscopist who has never seen a microscope used in conjunction with a heliostat has yet to learn the possibilities and advantages of such a form of illumination.

Residents in the British Isles have a substantial excuse for not using the heliostat because of the uncertainty of getting bright sunshine at the time of working; still the intermittent occasions on which it could be employed would well repay them for their trouble.

Microscopists with leisure would find it more useful than those who have few opportunities of working in the day time, while those who live in foreign countries where continuous sunshine can be depended upon are strongly recommended to make trials of a heliostat.

Its advantage is especially indicated in the illumination by monochromatic light, for which purpose two right angle prisms of dense glass with about 1½ inch face are necessary, with half a rapid rectilinear lens to concentrate the light upon the prisms and the remaining half placed to receive the spectrum as it emerges from the prisms.

The microscope should be placed at some distance, say 12 to 15 feet, from the prisms, the height of the heliostat being so arranged that the beam from it shall fall upon the microscope mirror. A strip of card should be set in front of the microscope on a level with the mirror, and the room darkened as much as possible, when it will be found, if the prisms are nicely adjusted, that a brilliant image of the spectrum is projected. By slightly moving the prisms or the microscope the exact wave length of light that is desired for the work in hand can be selected, and that wave length used for the examination or photography of objects. The brilliance of illumination secured under these circumstances is so great that light well into the violet end of the spectrum can be satisfactorily utilised, and the resolving power of objectives increased thereby.

No ordinary light filter passes light of one wave length or even approximately so; by means of a heliostat a far more exact result can be secured, especially when by the method named above, a spectrum measuring 20 inches or more in length can be obtained at the microscope mirror.

Those who work with a heliostat once will anticipate further sunny hours for improving their acquaintance with it.

Labelling Specimens.—It is often desirable when mounting specimens to have at hand some ready means of marking them for future identification. The so-called grease pencil for writing on glass, which may be had in various colours, and can be purchased from many opticians, is one of the handiest and neatest means, especially as the writing can be removed subsequently with a little warm water.

Another device where labels are not at hand is to pass the glass slip across the tongue, allow the dampness to dry, after which an ordinary pen and ink can be used for writing upon the portion so treated.

In the case of specimens mounted on cover glasses or slides, which it is required to identify after passing through various solutions, the following method is recommended.

Mix into equal parts of egg, albumen and glycerine, sufficient lampblack to make a good black fluid; this may be used with a steel pen for writing on a cover glass or slide, after which the glass should be held over a flame until the characters are dry; glasses so treated will not lose identification marks if placed in solutions.

Photo-micrography with Simple Means.—Workers with limited means are often tempted to make attempts at photo micrography but are appalled by the number of fittings that are usually specified as necessary. It has to be borne in mind that it is not everyone who is bent on performing feats of resolution of diatoms or working with high powers; in making observations there are numerous enthusiastic amateurs, who, seeing a striking feature in an object, wish to record the appearance by photographing it for future reference or for the edification of friends. The bulk of such work would lie within the scope of 1" or ⅔" objectives, and many of the ordinary fittings of complete photo-micrographic cameras are not really necessary, however desirable they may be.

What is the simplest apparatus that can be used?

Being provided with a microscope and bull's eye, the additional apparatus would consist of an oil lamp, some form of camera, a support that will carry the camera at the axis height of the microscope when set horizontally, and a tube to connect the front of the camera with the body of the microscope.

1. *The Lamp.*—This need not be of an expensive kind such as is ordinarily supplied for microscopical work. One with a tin frame which is purchasable at an oil shop for 1s. answers very well. 2. *The Camera.*—This should not have less than 10" of extension and requires to have a good dark slide with it. The focussing would, of course, be done by means of the microscope adjustments. 3. *The connecting tube* might be of cardboard or of brass as preferred. 4. *A support for the Camera.*—This is really of great importance in an arrangement of this description. It would be well that a frame should be shaped up by a carpenter to which the camera could be attached and on which, at a suitable level, the microscope and lamp could be placed in a fixed central position.

A knowledge of photography is so general that it is hardly necessary to say that an acquaintance with developing, printing, etc., is desirable; but with such contrivances as those named, carefully arranged, really good results can be secured with low-power objectives.

Success under such circumstances will lead to a desire to attempt more pretentious work with better apparatus. Photo-micrography has a charm of its own, but in order to attain proficiency it is essential that the worker possess a good practical acquaintance with microscopical manipulation and ordinary photography. The failures that are so frequently met with are due in the majority of instances to ignorance of one or both subjects, in fact, the writer has met with people who have essayed to do photo-micrography without previous serious work with the microscope or knowledge of its limitations. A serious practical man can succeed with elementary arrangements where a novice with the best equipment of apparatus would fail.

Low-priced Objectives.—Perhaps in nothing so much as in scientific work is the fear present that anything that is low in price is likely to be poor in quality and yield corresponding results. But it can be claimed that this does not apply to microscopical objectives.

The past decade has seen a wonderful forward movement in the construction of these lenses. The almost general use of the microscope in laboratories, technical schools, for manufacturing purposes, and even in primary schools, added to the increasing recognition of its value as a means of recreation, has created a demand which has been at all times a critical one. There have always been the few who have been quick to recognise merit in lenses and to make their virtues known. Manufacturers have vied with each other, and by the use of the many optical glasses that are at their disposal, combined with extensive computations and experiments and skilful work, they have produced lenses of large aperture and fine performance. When apochromatic objectives were first introduced their performance was in the majority of cases immeasurably superior to others. These have been taken as a standard, and many lenses at very low cost are being made that are practically equal to them excepting only so far as the colour corrections are concerned

It must not be inferred that this point is neglected, in fact it requires a critical eye oftentimes to detect an inferiority in this respect, but for the bulk of the work undertaken by microscopists it can be disregarded, and the cheaper lenses will reveal all that the apochromatics are capable of showing. These remarks apply to the products of nearly every firm of repute, and advice would be willingly given by such in the selection of lenses, which could be accepted without misgiving.

NOTES AND QUERIES.

J. E. S.—The reason why a condenser having a smaller aperture than that possessed by the objective is sufficient is because there are no lenses available that will bear an illuminating cone equal to their own aperture. As a rule definition begins to fail even with the best lenses when anything more than a cone of three-fourths the numerical aperture of the objective is employed. There have been exceptional lenses which have borne more than this, but they are rare. It would be well worth your while to have an oil immersion condenser if you were using an objective with a N.A. of 1·40. It is possible that this lens would stand a cone slightly in excess of 1·0 N.A., and the best dry condensers do not give much more than ·9 The cone of illumination required depends in a large measure on the subjects that are under examination; for a large amount of work a cone of ·9 would be quite sufficient for a lens of 1·40. Directions for the regressive staining method are contained fully in the "Microtomist's *Vade Mecum*," by Lee. Several pages are there devoted to the subject. The process could not be briefly described in these columns.

A. Glaister.—I am sorry to say that when the tubes containing the Infusoria you so kindly sent reached me, the contents were dead and quite disintegrated. It was therefore impossible for me to identify any of the specimens. Should you wish to send others, perhaps you would let me have advice a few days in advance so that I could arrange to receive and examine them promptly.

B. R. I. (Mysore Province).—When it is desired to show the contents of cells and vessels in woods, the sections must be cut, and mounted, dry. The best tools for making large sections of hard wood, are a carpenter's bench and a good plane. Longitudinal sections of almost any size can be cut in this way, and they can be trimmed up and the ends cut square with a pair of scissors. Then, if desired, they may be soaked in water and mounted in glycerine jelly. If the cell contents, viz., oils, turpentine, or resin are required to be shown, the sections must not be placed in alcohol because it would dissolve such contents: they consequently cannot be mounted in Canada balsam. I do not know of any microtome that will cut transverse sections of hard tissues of a large size. The one you refer to—Cole's pattern—is a very good one, but I am afraid that paraffin would not do for embedding, especially in India: a good firm piece of carrot is the only thing I know of. For instructions in staining and mounting, I would recommend Lee's "Microtomist's *Vade Mecum*," and for practical botanical histolgy Strasburger's "Practical Botany" (Swan Sonnenschein & Co.). I do not know of a book on entomology suitable for microscopists. The makers of lathes, etc., for grinding and cutting sections are Messrs. Cotton & Johnson, of 14, Gerrard Street, Soho, W., whom I have asked to send you a price list. A good practical work on the subject is "The Study of Rocks," by Rutley (Longmans).

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. Cross, Knowledge *Office*, 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. Denning, f.r.a.s.

Encke's Periodical Comet.—The re-detection of this comet is announced by Prof. Wilson, who saw it on August 6th, in the approximate position R.A. 6½°, Dec. 31° 43′ N., so that the comet was close to μ Andromedæ. The period of revolution being 3·3 years, the returns of this object occur at intervals of 33 years (10 periods), when the circumstances of its visibility are nearly the same as before.

Comet 1897. I. (Perrine).—Dr. Johannes Möller has investigated the observations of this comet extending over the period from 1896, November 2, to 1897, April 29, and deduces hyperbolic elements. He finds the excentricity 1·000327, and gives a table in which is compared the orbital elements of seven other hyperbolic comets, viz.: 1844, III., 1886, II., 1889, I., 1890, II., 1892, II., 1898, VII., and 1899, I.

Ernst August Lamp.—Dr. Lamp, of Kiel, whose name is well known in connection with cometary investigations, died on May 10th, 1901, aged 51 years. Included in his valuable labours were a computation of the definitive elements of Comet 1891, I., and a discussion of the supposed connection, first pointed out by Mr. Hind, between Brorsen's Comet (1846) and Comet 1894, I. (Denning). He gave his conclusions on the latter subject in *Ast. Nach.*, 3278, and showed that the two comets made a very close approach to each other in January, 1881.

THE JULY METEORS.—The month was not altogether favourable for observation, temperature being unusually high and accompanied with considerable mist. At Bristol the writer maintained a watch on seven nights between the 15th and 24th inclusive, and saw 95 shooting stars in 14¼ hours of observation. The first certain indications of the great Perseid shower were noticed on the night of July 21st, when five meteors, of the usual rapid, streaky, type, indicated a radiant at about 23° + 52°. But the most interesting as well as the most active display of the period was from a point at 290° + 24° near β Cygni, which furnished some slow-moving trained meteors of a yellow colour. There was also well marked radiation from other points, and particularly from Capricornus, Delphinus, Cygnus, Andromeda and Triangulum, but the meteors registered intimated a large number of feeble radiants rather than the special activity of a few. The most productive nights were July 20th and 21st when meteors were fairly numerous, but on July 15th, 16th, 18th, 19th and 24th they were decidedly scarce, though the sky was favourable.

THE FACE OF THE SKY FOR SEPTEMBER.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 5.15, and sets at 6.45; on the 30th he rises at 6.1, and sets at 5.39. The sun enters Libra, and Autumn commences at 6 P.M. on the 23rd.

THE MOON.—The moon will enter last quarter on the 5th at 1.27 P.M., will be new on the 12th at 9.19 P.M., will enter first quarter on the 21st at 1.33 A.M., and will be full on the 28th at 5.36 A.M. The most notable occultation during the month is that of ε Tauri, mag. 3·7, which takes place on the morning of the 5th; disappearance at 4.2 A.M. at 123° from the north point (146° from the vertex); re-appearance at 4.58 A.M. at 221° from the north point (230° from the vertex).

THE PLANETS.—Mercury is an evening star throughout the month, but unfavourably placed for observation in northern latitudes.

Venus is also an evening star, but still unfavourably situated for naked-eye observations. Throughout the month the planet sets about an hour after the sun. On the 15th the apparent diameter is 13″·6, and the illuminated part of the disc 0·795.

Mars remains an evening star, setting about 8.12 P.M. on the 1st, and about 7 P.M. on the 30th. The path is from the south-eastern part of Virgo into Libra. On the 21st the planet passes about a degree to the south of α Libræ. The apparent diameter diminishes from 5″·0 to 4″·6 during the month.

Jupiter may still be observed in the evening; on the 1st he crosses the meridian at 7.33 P.M. and sets at 11.21 P.M., while on the 30th he crosses the meridian at 5.45 P.M. and sets at 9.33 P.M. During the month the polar diameter diminishes from 39″·0 to 35″·6. The movement of the planet is easterly, through the western part of Sagittarius; in quadrature on the 28th. The principal satellite phenomena are as follows:—

			H M				H M
1st.—	I. Ec. R.	...	8 24·2	13th.	II. Tr. I.	...	8 54
2nd.—	III. Oc. R.	...	7 46	15th.—	I. Oc. D.	...	8 42
	III. Ec. D.	...	9 34·9		II. Ec. R.	...	8 43·1
3rd.—	IV. Sh. I.	...	9 28	16th.—	I. Sh. I.	...	7 10
6th.—	II. Sh. I.	...	8 54		I. Tr. E.	...	8 10
	II. Tr. E.	...	9 12		I. Sh. E.	...	9 28
7th.—	I. Tr. I.	...	9 31	20th.—	III. Sh. I.	...	7 20
	I. Sh. I.	...	10 45	23rd	I. Tr. I.	...	7 17
8th.—	I. Oc. D.	...	6 49		I. Sh. I.	...	9 5
	I. Ec. R.	...	10 19·2	24th.	I. Ec. R.	...	8 38
9th.—	I. Sh. E.	...	7 32	27th.—	III. Tr. I.	...	6 5
	III. Oc. D.	...	8 27		III. Tr. E.	...	9 13
11th.	IV. Oc. D.	...	6 58	29th.	II. Oc. D.	...	8 29
	IV. Oc. R.	...	9 28				

Saturn remains a few degrees to the east of Jupiter, setting on the 1st at 11.55 P.M., and on the 30th at 10.1 P.M. The planet has a slow westerly movement until the 11th, when it is stationary, and an easterly movement during the remainder of the month. On the 15th the major and minor axes of the outer ring are respectively 39″·8 and 17″·2, while the polar diameter of the ball is 15″·8. The northern surface of the ring system is presented towards the earth.

Uranus is in the southerly part of Ophiuchus, and may therefore be observed in the western sky for a short time after sunset. On the 1st the planet sets about 10 P.M., and on the 30th about 8.8 P.M. During the month the planet describes a short easterly path nearly midway between Antares and η Ophiuchi. The planet is in quadrature on the 6th.

Neptune is again coming into position for evening observations, the planet rising about 10.30 P.M. at the middle of the month, and being in quadrature on the 25th. During the month a short easterly path is described in the western part of Gemini. On the 11th, the planet is 3 minutes preceding and 15′ 20″ south of η 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 and extending 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 Bootes to the north of west; and Ursa Major nearly due north.

Minima of Algol occur on the 1st at 7.36 P.M., and on the 21st at 9.18 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 August Problems.

No. 1.

(W. S. Branch.)

1. Q to B3, and mates next move.

No. 2.

(W. Clugston.)

1. R to Kt 5, and mates next move.

No. 3.

(W. H. Gundry.)

1. Q to QB8, and mates next move.

[There is unfortunately an alternative method by 1. Kt to Q6ch.]

CORRECT SOLUTIONS of the three problems have been received from J. Baddeley (6), H. Le Jeune (6), G. Groom (7), F. J. Lea, (6), G. A. Forde, Capt. (7), S. G. Luckock (6), W. de P. Crousaz (7), W. H. S. M. (7), C. C. Massey (6), Eugene Henry (6), G. W. (7), Alpha (6), G. W. Middleton (7), W. Nash (7), A. C. Challenger (7), W. Jay (7), Vivienne H. Macmeikan (6), F. V. Louis (7), C. Johnston (7), F. Dennis (7), J. E. Broadbent (7).

A. E. Whitehouse has solved Nos. 2 and 3 correctly, W. H. Boyes Nos. 1 and 2. C. F. P. scores 4 points for the three problems, 2 being deducted for incorrect claims.

J. T. Blakemore.—No solutions received from you this month. Did you post them?

F. J. Lea.—Your solutions last month were too late to count.

G. A. Forde.—B × R will not solve No. 3. The Black Queen can give check. But as this is an incorrect claim for a third and not for a second solution, no points have been deducted.

W. H. S. M.—P to K3 is met by R × P. You nevertheless score 3 points for No. 3, for the reason stated immediately above. Correction to solution of No. 2 received just in time.

A. E. Whitehouse.—K to B2 exposes the White King to check.

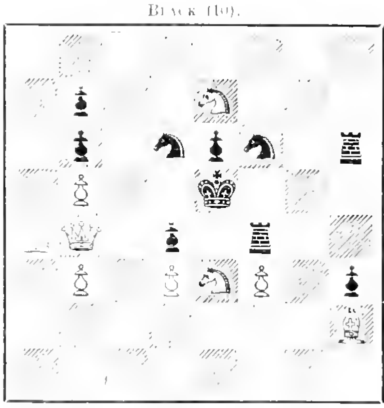
C. C. Massey.—Obviously the solution Kt to Q6ch was not intended by the composer. The solution to the June three-mover is, as was clearly stated in the July number, P × B, becoming a *Bishop*, not a "Knight" as you quote. But if the White Pawn were to become a Queen, then the *Black* Pawn would become a Knight, and stalemate would result.

PROBLEMS.

By C. D. Locock.

No. 1.

BLACK (10).



WHITE (9).

White mates in two moves.

No. 2.

BLACK (11).

WHITE (8).

White mates in three moves.

The following are now leading in the Solution Tourney:—

Forty-five points.—C. Johnston, A. C. Challenger, W. Jay.

Forty-four points.—S. G. Luck, W. H. S. M., G. Groom, F. Dennis, G. W. Middleton.

Forty-three points.—J. Baddeley.

Forty-two points.—H. le Jeune, W. de P. Crousaz, G. W. Forty-one points.—W. Nash, J. E. Broadbent.

Forty points.—Vivienne H. Macmeikan.

Thirty-nine points.—C. C. Massey, Alpha.

Thirty-eight points.—G. A. Forde.

It will be seen that the number of those who have scored the maximum possible number of points is now reduced to three; but fifteen others follow them at very close intervals, and the competition is evidently reaching its most exciting stage.

The following is the solution of Mr. H. Wood's problem:—

Place the White Pawns at Q5, K5, KB5, KKt5, KR5, K6, KB6, and KKt6. Black's best methods of prolonging the game are—

(A) Kt to KR3; 1. KtP × BPch, Kt × P; 2. P × Ktch, K × P; 3. P to Kt6ch, P × P (best); 4. RP × Pch, K moves; 5. BP mates.

(B) QP × P; 1. P × PBch, K × P (best); 2. KtP checks, RP × P (best); 3. RP × Pch, K moves; 4. BP checks, K moves; 5. BP × P mate.

G. W. Middleton sends a solution, but with 9 White Pawns.

CORRECTION. The composer of the "eight Pawns problem" has just discovered that Black has a satisfactory defence in 1. KP × BP, and that *nine* Pawns (the number postulated by Mr. Middleton) are required for the purpose. As Mr. Wood himself justly remarks, this necessity for an extra Pawn deprives the puzzle of all its point.

CHESS INTELLIGENCE.

A match between Messrs. F. J. Lea and R. Teichmann was recently concluded at 37, King Street, Covent Garden, a former home of the British Chess Club. Mr. Teichmann proved victorious by 5 games to 2.

Many chess-players and others will learn with regret the news of the death of the Rev. J. Coker, of Tingewick, Bucks, at the age of 76. Mr. Coker was formerly captain of the Winchester College Cricket Eleven, and played also for Oxford University. As a chess-player he was well known at most of the meetings of the Counties Chess Association, where he was always a formidable competitor.

The final contest for the Southern Championship took place at Reading on July 20, when Surrey encountered Gloucestershire. In order to retain their title Surrey had not only to win the match, but to win it by a majority of at least $9\frac{1}{2}$ to $6\frac{1}{2}$, for reasons stated in the August number. With this object in view, Surrey put a very strong team into the field, and, though the scoring on the first six boards was quite even, they obtained a decisive majority on the remainder, and won handsomely by 11 games to 5. Mr. D. Y. Mills took charge of board No. 1 for Gloucestershire, and defeated the Surrey Champion, Mr. Herbert Jacobs.

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

The yearly bound volumes of KNOWLEDGE cloth gilt, 8s. 6d., post free.
Binding Cases, 1s. 6d. each; post free, 1s. 9d.
Subscribers' numbers bound (including case and Index), 2s. 6d. each volume.
Index of Articles and Illustrations for 1891, 1892, 1894, 1895, 1896, 1897, 1898, 1899, and 1900 can be supplied for 3d. each.

All remittances should be made payable to the Publisher of "KNOWLEDGE."

"Knowledge" Annual Subscription, throughout the world, 7s. 6d., post free.

Communications for the Editors and Books for Review should be addressed Editors, "KNOWLEDGE," 326, High Holborn, London, W.C.

KNOWLEDGE
AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

VOL. XXIV.] *LONDON: OCTOBER, 1901.* No. 192.

CONTENTS.

FLOWERING PLANTS,
AS ILLUSTRATED BY BRITISH WILD-FLOWERS.

By R. LLOYD PRAEGER, B.A.

V.—DISPERSAL AND DISTRIBUTION.

To resume the consideration of the means employed by plants to ensure a wide dispersal of their seeds. We have seen how much the available motive agents—wind, water, animals—are taken advantage of. There is, in addition, a large number of plants which do not rely on any external agency to carry their seed, but do the scattering themselves, by one or another ingenious device. If we lie on a sunny bank among the Gorse in August, we shall hear a sharp snapping noise coming from the prickly bushes at frequent intervals. This is due to the sudden rupturing of the ripe pods, owing to unequal shrinkage caused by their drying. The walls of the fruit are composed of layers of cells which vary in the amount to which drying causes them to contract. When the stress due to the irregular contraction thus produced reaches a certain point, the walls give way and each half of the pod jerks into a spiral form, projecting the enclosed seeds to a considerable distance.

Examine a fruit of the common Dog Violet. It is a little capsule formed of three sections. As it ripens it opens along the lines of junction of these, and we get three narrow boat-shaped valves, projecting horizontally from the fruit-stem, and each containing several seeds. The drying of these valves causes contraction. The two gunwales, so to speak, of each boat are drawn together, pressing more and more tightly on the seeds which lie between, till one by one the seeds spring out with considerable force.

In other cases a similar violent expulsion of the seed is caused by unequal growth in the tissues of the seed-vessel. This it is that produces such a state of stress in the five-parted capsules of the Touch-me-not that when ripe a puff of wind or a light touch causes a violent explosion of the fruit, by which the seeds are scattered far and wide. A more familiar example may be studied in the little Hairy Cress, so common a weed in gardens. While weeding a bed early last June, in which there was a quantity of this plant, which had unwisely been allowed to exceed the period of flowering, the bursting of the little narrow pods and the flinging of hundreds of seeds in my face amounted to a positive nuisance, and caused reflections concerning the wisdom of an old saying about a stitch in time.

Some of the Crane's-bills fling their seeds to a considerable distance by means of a more complicated apparatus. The fruit consists of five separate carpels attached by their apices to a spindle. Each carpel consists of an egg-shaped pouch containing one seed, pro-

FIG. 1.—The Bloody Crane's-bill, showing [illegible] fruits. [illegible] nat. size.

longed into a slender rod, the whole adpressed to the spindle, so that the five pouches lie in a ring round its base. Each pouch is open on the side which is pressed against the spindle. As the fruit ripens the more rapid shrinking of the outer layers of the rod of the carpel causes it to rupture the tissue which attaches it by its whole length to the spindle, and it curls with a jerk, carrying up the pouch and causing the seed to fly out of the opening on its inner side already referred to. Lord Avebury placed fruits of the Herb Robert on his billiard-table, and found that the seeds were in this manner projected to a distance of over twenty feet. Fruits of this kind have been aptly named sling-fruits. Nor is it beyond the powers of certain species to undertake even the *planting* of their seeds. The Stork's-bills (*Erodium*), which are closely allied to the Crane's-bills or Geraniums, have curious fruits, each consisting of a torpedo-shaped seed prolonged into a slender twisted rod, which terminates in a long appendage set at right angles to the axis of the remainder of the fruit. The seed is furnished with bristles pointing away from the unattached end, and the twisted tail is hygroscopic—very sensitive to moisture. Now, if the seed be held fast, and the whole moistened, the rod will untwist, and as a result the free end will revolve like the hand of a clock. But if, as will more likely happen in nature, this revolution causes the long appendage to come in contact with some obstacle—a blade of grass, for instance—then the motion will be transferred to the seed-bearing end, which will revolve like an auger, and, as a result of the lengthening caused by the untwisting of the rod, the seed will be forced into the ground. The upward pointing bristles will come into play if the rod dries again, tending to hold the seed down in its place in spite of the contraction, and to drag down the opposite end instead; another moistening will cause the seed to burrow deeper. A much simpler, but very pretty instance may be watched in the little Ivy-leaved Toad-flax, a plant of the European continent which has now spread over the greater part of the British Islands. It grows on walls, and when in flower the pretty purple Snapdragon-like flowers stretch out towards the light and air. But as the fruit ripens its stem bends towards the wall, and seeks the deepest cranny it can find, in which the seed may be deposited. Owing to this arrangement, the fruit needs no winged appendage or other device such as is possessed by so many wall plants, to prevent the seed from falling uselessly to the inhospitable ground below.

Fig. 2.—A Fruit of the Musky Stork's-bill. × 2.

Thus far regarding the dispersal of plants by means of their seeds. We have not yet nearly reached the limit of power of spreading which our wild flowers possess, for vegetative reproduction plays a most important part in this chapter of their life-history. We may, if we wish, separate the latter processes into two groups, according as to whether the new shoot separates from the parent plant or remains, for some time at least, attached to it. In all cases it is of great importance to note that reproduction of this kind is not due to the *offspring* of the plant, but to a portion of the parent itself, which sooner or later commences an independent existence; it is due to a prolongation of the life of a single generation, not the production of a new generation. In some instances it is the new shoot alone which survives from one season to the next. If we examine in autumn a plant of one of the Bladderworts—pretty floating plants with limp straggling stems and no roots—the stem will be found to terminate in a rough egg-shaped knob. If we examine a plant in early spring, the stem is seen to arise from a similar knob. A rootless floating plant like this would get killed during the winter by being frozen into the ice; so it concentrates its vitality in these knobs—in reality much compressed stems—which sink to the bottom, while the rest of the plant decays, and lie snugly there till spring, when they rise again and send out fresh elongated stems, with leaves and flowers. Similar winter buds, or *hibernacula*, may be seen on the Frog-bit, certain Pond-weeds, and other aquatic plants. In these cases the buds are terminal, and represent the contracted stem, which really grows on year by year, being elongated in summer, contracted in winter.

Bulbils are found on a variety of plants. They are little adventitious buds borne on the stems or leaves, or in lieu of flowers, which sometimes remain attached to the parent, sometimes drop off to commence at once a separate existence. In the proliferous section of the protean varieties of the Soft Shield Fern (*Polystichum angulare*), for instance, they may be seen crowded along the rachis or midrib of the frond, and in a damp atmosphere form a verdant row of little ferns before the decay of the frond allows them to reach the ground and take root. In the Lesser Celendine, again, little egg-like bulbils are borne in the axils of the leaves; they drop off and immediately commence life on their own account. Many of the species of Leek and Onion (*Allium*) are conspicuously bulbiferous, the umbel of flowers being crowded with little bulb-like buds which sometimes altogether replace the blossoms.

In the majority of instances the increase of plants by vegetative reproduction is accomplished by means of the continued growth of their stems, some or all of which, instead of rising erect, creep on or below the surface of the ground, giving off, continuously or at intervals, roots below, leaves and flowers above, and capable of quite indefinite extension—see the first article of this series (*supra*, p. 27). The common Polypody grows on and on year by year in this manner, the hinder end of the stem dying by degrees. The Butterbur, whose great leaves form such picturesque masses of foliage on our river banks, grows similarly, with a stem which pushes its way below the surface. Instances where roots and shoots are produced only at intervals are equally common—the Strawberry and Silfast are familiar examples. Underground stems of the same kind are abundant. These it is that are so useful in binding together shifting sands—stems like those of the Bent, Lyme-grass, Sea-sedge. The growth of the last-named (*Carex arenaria*) is most interesting. On bare sandy patches one may note the tufts of leaves and flowers rising at regular intervals in a straight line for several yards. Digging a few inches downwards, we discover the connecting stem, running straight and level underground, and terminating in a long point, white, polished, and hard as ivory, which pushes its way ever forwards through the sand.

Bramble-stems often form a high arch in the earlier part of their yearly growth; but in the autumn they curve earthwards, and the growing point enters the soil, where it roots and turns sharply upwards again. Next year the arched stem flowers and dies, but a new plant starts from the rooted tip; and so the bramble goes looping along year by year. A few years ago I noted a bramble-bush with rooted shoots averaging over 20 feet in length; a calculation will show that in six years, at the same rate of growth, a single bush might cover an acre of ground.

The well-known "fairy rings" of pastures are produced by the continuous growth of the *mycelia*, or webby underground stems, of certain fungi. These, starting from one point, and spreading regularly, exhaust the soil in which they live, so that as their area of growth expands, the central portion keeps dying off, and a slowly enlarging ring of growing fungus results. The visible effect produced is due to the fact that the plant acts injuriously on the surrounding vegetation producing a withered ring where the fungus is growing. But inside of this is a ring where both the fungus and its victims have died, and on the soil thus left untenanted, and enriched by the dead vegetable matter, a luxuriant vegetation has sprung up, which catches the eye. Rings formed in a similar manner, by steady outward growth and the dying off of the older central portions, may be not unfrequently observed among the higher plants.

Roots also lend themselves sometimes to vegetative reproduction, producing leafy shoots, which become independent plants. The White Poplar is often surrounded by progeny of this kind, and the Sea Buckthorn covers large areas of sand-dunes by the same means. Tubers, such as those of the potato, are also really stem-structures produced by the roots.

Having thus briefly reviewed the various modes in which seed is dispersed and scattered, and also those by which vegetative reproduction is carried on, we are now in a position to study the distribution in any given area of the various species which compose its vegetation, so far as this is the result of its methods of reproduction. In the case of plants which produce flying fruit, we should expect to find the individuals very widely spread and generally growing singly, in open situations such as these species affect, where in turn their flying fruit may be freely exposed to the wind which will bear it away. Plants of which the fruit is eaten by birds should likewise have a wide distribution, and we might perhaps especially expect these about bushes and hedges, wherein birds would perch or shelter. Where no devices exist for a wide dispersal of seed we might look for a more social grouping of individuals in little colonies or dotted over larger areas. And in the case of plants which can increase by means of their creeping stems, we might often expect to find dense growths, and if I may use the expression, populous cities. At the same time it must be remembered that all sorts of other conditions and requirements exist simultaneously to modify or obscure such groupings; but the general application of these rules will at once be observed by the field botanist. Our common thistles, for example, have flying fruits; furthermore, their formidable armour of spines renders them invulnerable to grazing animals; hence we find them scattered far and wide over the pastures. The Field Thistle has far-creeping underground stems; hence it forms dense patches, almost impossible to eradicate, while the Spear Thistle and Marsh Thistle, destitute of creeping stems, rise singly. The Wood Anemone, growing in shady places, could not use flying seeds to advantage; the seeds are devoid of means of wide dispersal, and the stems creep; both causes combine to make the plant grow in the lovely dense sheets of tender green dotted with white flowers that we know so well. Its ally, the Pasque-flower, on the contrary, lives on the open downs. The stems do not creep, the fruit is formed for wind-carriage; in consequence we find the plant dotted here and there over wide areas. Most of our wild flowers which have bulbous "roots" produce young bulbs as offshoots of the parent ones, thus tending to establish dense colonies—note the profusion in which the Wild Garlic (Fig. 3) and the Wild Hyacinth grow. Many of our marsh and water plants have creeping stems, which tend to produce striking masses of vegetation—witness the miniature forests of the Reed, Bulrush, Reed-mace, or Sedge which fringe the ponds and lakes, often so dense that no other plant can obtain a footing among them. Certain common land plants with creeping stems and large leaves, such as the two more familiar species of *Petasites*—the common Butterbur and the Winter Heliotrope (Fig. 3)—form such dense masses of foliage as to effectually choke off and kill all other plants on the area which they invade. On the hill-sides, two of our most strongly social species—the Heather and the Bracken—often come into sharp contest, each holding undisputed sway over certain areas, with a border-line where no doubt a keen struggle is continually going on—the Bracken having the advantage of creeping branching rhizomes or underground stems, and tall dense growth which over-shadows its rival; the Heather on its side being possessed of great vitality and fertility, and perhaps other less evident advantages, which enable it to hold its own.

Fig. 3.—A Study in Gregarious Plants: Winter Heliotrope, Ramsons, and Ivy.

But as we have said, many other factors are at work influencing the distribution of plant life—questions of soil and of situation; of water supply, and the supply of air and light; and there is the keen struggle for existence between plants of similar proclivities; and a complicated and incessant action and reaction not only between plant and plant, but between plant and animal—between the plant, indeed, and its whole environment. We thus find, in any selected area, a group of plants, often differing widely in size and appearance, in mode of growth and mode of dispersal, which nevertheless forms a strictly natural group, living together by reason of their being adapted to the particular conditions of life which prevail. To such natural groups of the vegetation the name of *plant associations* has been given. Such an association is often dominated by one or more social species, which, growing in great numbers, control more or less the entire association. In other cases, though some plants may be more abundant than others, the association may be a commonwealth rather than a monarchy. Let us glance at a few instances. On the sandy sea-shore, vegetation is limited, but between the reach of the waves on the one side, and the bent-covered dunes on the other, a certain number of plants maintain an existence. The Sea-Holly is here, with its leathery spiny foliage; the bushy succulent leafless prickly Salt-wort; straggling plants of Orache; the beautiful Horned Poppy, with its grey downy foliage and splendid yellow blossoms; the Sea-Rocket, also of bushy growth, with tough stems and succulent shiny leaves; and the Sea-Spurge, which matches the Sea Holly and Horned Poppy in the grey tones of its foliage. What conditions have determined the selection of this group of plants? In winter the sea washes right over these sands, and even in summer the air is full of salt. Very few plants could endure the salinity which pervades the place; but these particular species not only endure it, but cannot exist without it; we find them nowhere but on the edge of the sea. Next, the exposure here is very great. The wind whistles along these bare sands, carrying spray, or driving sand. The plants are all low, tough, bushy, strong-rooted, suitable for withstanding gales. Heat and drought are much felt here, and would prove fatal to many species; but all these have roots which strike deep into the sand; some, like the Salt-wort and Sea Rocket, store up a large reserve supply of water and food in their fleshy leaves; others like the Sea Holly, in their long juicy underground stems; and all provide against too great transpiration, by means of a thick impermeable skin, or a felt-like covering of hairs; often accompanied by a reduction in the number of stomata—the pore-like openings of the leaves. Competition can play but little part in the economy of this plant association; there is room for plenty more; the abundant space allows each plant to spread out, low and bushy. Human interference is also at a minimum here, and animal depredations likewise—though we note that the Sea Holly and Salt-wort both provide for this contingency in the production of a formidable array of thorns. The dominant conditions are undoubtedly the saltness and the exposure; these are the features of the environment that have chiefly determined the limits and character of the plant association.

Let us take an example of quite another kind—a wood of Beech. Here the tall trees form the leading feature, and dominate the whole association. The deep shade cast by the foliage precludes a large number of plants from trespassing here or enjoying the thick layer of leaf-mould which has formed; the few that have crept in are spindly and sickly from their vain efforts to obtain a sufficiency of light. But even the denser portions of the wood are inhabited by a variety of herbs, and on examination, we find we may group these under two heads: (1) spring flowers, such as Primroses, Wild Hyacinths, Wood Sanicle, which by growth early in the season produce their leaves and blossoms before the foliage overhead has yet screened out the sun and rain; and (2) saprophytic plants, such as the Bird's-nest Orchis, which, instead of attempting to manufacture plant-food by means of green leaves and sunlight, derive their plant-food ready-made from the decaying vegetable matter, and thus are enabled to flourish in the gloomiest recesses of the forest. In this case the Beech forms a strongly dominant species; the subsidiary vegetation being influenced chiefly by the limitation in the supply of light. It is to be noted that the conditions which exclude so many plants are advantageous or necessary for the members of the association. Were the trees cut down, the saprophytes would disappear at once, and most of the other plants would seek a more sheltered habitat.

Consider next the conditions prevailing in a pasture. Here intense competition is going on; every scrap of the surface is densely covered with vegetation; and in addition, grazing animals are perpetually nibbling the herbage, destroying the leaves and flowers. Note the upright growth of all the plants composing the association, and the narrow leaves which most of them have assumed, to get up into the light and air as far as possible with the least expenditure of material. Several species of grasses are here dominant species; some *Compositæ*, such as Daisies, Hawk-bits, and Cat's-ears, also appear well able to hold their own. There is also an interesting group of semi-parasitic *Scrophulariaceæ*—the Eyebright, Yellow-rattle, and Red-rattle, which, when they get a chance, help themselves and hinder their neighbours by fastening on the roots of the latter and drawing therefrom plant food ready-made. Most of the species are perennials, almost the only annuals being the group last mentioned, which are certainly advantageously circumstanced. The plants comprising such an association must be very hardy species, able to hold their own in a keen struggle for room, and to produce fresh leaves and perfect their flowers and fruit in spite of the depredations of the sheep and cattle.

Or to take, finally, the vegetation in the centre of a great turf-bog. Here, again, we revert to conditions entirely uninfluenced by man or by grazing animals. We have again a strongly dominant species—the Ling. Competing with it for dominion we may have one of several others—the Bog Asphodel, or one of the sedges. The supremacy varies according to the degree of moisture. On the drier portions, the Ling easily holds its own; but where the peat is wetter, the Bell-Heather is a dangerous rival; and where water usually lies, the Beak-rush holds sway. Compared with the flora of the pasture, the variety of plant-life is very limited—perhaps not more than a dozen species in as many square yards; very few plants can tolerate the peculiar conditions which prevail—the intensely peaty soil, the soaking spongy ground, and the competition of the over-mastering Ling.

THE WHITE NILE—FROM KHARTOUM TO KAWA.

AN ORNITHOLOGIST'S EXPERIENCES IN THE SOUDAN.

By Harry F. Witherby, F.Z.S., M.B.O.U.

IV. CAMPING AND COLLECTING.

Whilst travelling up the river we had noted different places where the country seemed most suitable for birds, and for making collections. Arriving at such a spot on our return journey, if satisfied with our former choice, we selected the shadiest tree available under which to pitch the tents, and setting our "trusty" followers to work, we soon had a camp neatly arranged and in working order. While one of us remained in camp, the other two sallied forth to the hunt.

Most of our work was done between five and eleven in the morning. From eleven to three we rested in the shade, and from three until sunset we were collecting again. But the morning hours were generally the most profitable, the afternoon being hotter and often spoilt by a sandstorm, while in the evening a necessary slaughter of pigeons for the pot usually had to be undertaken. When out collecting each of us was accompanied by a man to carry the birds and perhaps a spare gun and a water bottle. When five or six birds had been shot the man was sent back to camp with them so that no time should be lost in the skinning, and as decomposition often set in within two or three hours after death, we found this plan necessary as well as convenient. For carrying the birds we employed a stick, to which were tied at intervals pieces of thread, a space being left in the middle of the stick for the hand. To one end of each piece of thread was tied a small bit of cork and to the other a pin. When a bird was shot the pin was pushed through its nostrils and into the cork. The bird thus hung free from the stick and its plumage was in no danger of being rubbed and injured. Only one of our men showed any liking to come out shooting. They were not sportsmen. Innumerable excuses were invented when they were told to accompany us. But excuses were vain; answers could also be invented. Was illness pleaded, pills were administered, a species called the "Livingstone rouser" being most effective, but the man must come. Did a man say that he had lost his shoes and could not walk through the thorns, then he must take another's shoes and be quick. We had no mercy, nor had the companions of the malingerer. They laughed like children when an excuse was silenced.

As is always the case, or at all events wherever I have collected, certain birds, and generally the common ones, interfere with the collecting of others. We were much annoyed by a species of babbler* of about the size of a blackbird, and of a light brown colour, but with a white head, which was lucky for us, as it made them conspicuous and so easier to avoid. They were common where the trees and bushes grew thick, and were always in small companies. When we were unfortunate enough to come suddenly upon one of these companies the babblers seemed to go mad, whether with rage or terror I never could determine, and assailed us with an incessant stream of the hoarsest alarm-notes. This noise, for it can be called nothing else, was made up of a number of "churrs" so rapidly repeated that the whole sounded like a policeman's rattle turned with feverish anxiety. Moreover, the birds performed in company, sitting side by side on a bough and often touching one another. Were you so unwise as to try and drive them away they only retired to another bush and redoubled the noise. If you tried to creep away they followed you, advertising your presence to every other bird, and it was a long time before you could finally shake them off. Then there were four kinds of pigeons that were numerous and would rush out of a tree which you were carefully approaching, with such a flap that all the other birds took alarm, and a thick tree often contained twenty birds or more. In another way we were handicapped by two little birds, the pallid warbler† and the lesser whitethroat.‡ The majority of the birds in every thick tree or bush were sure to be either pallid warblers or whitethroats. The difficulty was to discover what else the bush contained. Many of the bushes were so thick that it was not until the birds came near the edges that they could be seen. A thorough examination might occupy a quarter of an hour and then perhaps no other birds but these two would be found. A good pair of binoculars is in every way the ornithologist's best friend, and although a glass should not be relied upon to too great an extent in identifying birds, it was of the utmost service in this work. I was the happy possessor of a pair of Goerz's Trieder binoculars. Everyone praises his own glass, but of all those I have tried none has been so good as this glass for my purpose. The power which magnifies nine diameters can be focussed and used perfectly easily with one hand, which is a great advantage, the definition is excellent, and although the "field" is not large, the glass is so light that it can be moved about quickly and with a little practice even a flying bird can be "picked up" immediately.

In this country of dense bushes and tame birds a knowledge of the notes of the birds was most valuable and a great saving in time. By a systematic identification of the performers all the commoner notes were quickly learnt, and then an unknown or doubtful sound proceeding from a thick bush at once drew attention. By means of these notes many of the rarer and smaller birds we obtained were first detected. For instance, one day I had got to the fringe of the wooded tract of country and had reached the beginning of the desert when I heard the sweetest possible little note proceeding from a thorn bush. The bush, although quite leafless, was so thick with green shoots that I could see no bird in it, but the note was so soft and delicate that I knew it must have been uttered by a tiny bird. I went some paces away and waited. After a time four or five most elegant little bush warblers§ appeared on the outside of the bush. Most refined little birds they were with most charming actions. They moved quickly and gracefully from twig to twig, and often fluttered to the ground in their search for insects, and except when actually flying they were incessantly flirting their long tails from side to side with a quick, jerky but dainty motion. We afterwards found these little birds in the acacia trees bordering the desert, and heard their warbling song, which was so soft that a near hearing and perfect silence were necessary for it to be fully appreciated.

In some cases, however, neither our glasses nor our ears were of any service in determining the species of a bird. Two birds which we obtained I thought at the time were reed warblers,|| but on a comparison at home one of them proved to be a marsh warbler.¶ Both these species come to England in the summer, and here in their breeding haunts their different nests and songs and habits make them perfectly distinct. But the birds we obtained were migrating from their winter abodes, perhaps much further south. The habits appeared to be exactly similar, they were not in song, nor did we hear them utter even a call note, so that there was nothing to differentiate them except their size or plumage. But in size they are exactly the same, while even with the two birds side by side in the hand their plumage is so

* *Crateropus leucocephalus* (Cretzschm.).

† *Hypolais pallida* (Hempr. et Ehr.). ‡ *Sylvia curruca* (Linn.).

§ *Spiloptila clamans* (Temm.). || *Acrocephalus streperus* (Vieill.).

¶ *Acrocephalus palustris* (Bechst.).

similar that no one but an expert would detect the difference.

It was most interesting to come across birds with which one was familiar in England in their winter resorts or on their migrations so far to the south. The extraordinary power of the migrating impulse was

FIG. 1.—Camp at Duem.

brought vividly home to me by the presence of a solitary red-throated pipit** feeding on the banks of the river some 1400 miles south of Cairo. Less than a year before I had seen this bird in its breeding haunts beyond the arctic circle in Russian Lapland, and I knew that it only nested north of the tree-limit. When I recalled my own journeys by boat and rail round the North Cape and then again down to Khartoum, and looked at the lonely, delicate little bird before me, it was almost impossible to realise that those feeble wings would in a few weeks' time be transporting that tender little body beyond the arctic circle.

I have said that we rested in the heat of the day, but a variety of causes generally kept us busy. There were birds to skin and label and pack, and notes to be written, then a gun was always kept handy, even at meal times, for the unknown birds which would often come unwarily into the tree over our tents and proclaim themselves by their notes. There were sheikhs to be salaamed and interviewed, and then our own followers required much attention. They stole from the natives, who naturally complained, they neglected the animals and the few duties we were able to put upon them, they were continually drunk with "boozer," and were always quarrelling and threatening one another's lives. All these little affairs had to be enquired into and dealt with during the mid-day "rest." Correction had to be administered usually in the form of the "korbag," laid on with no sparing hand by a companion of the delinquent. But they were accustomed to this, and a more effective form of punishment, reserved for special occasions, was to administer a kick with precision and power as though one were "placing" a goal at Rugby football. This not only hurt and surprised, but had the additional advantages of wounding the dignity of the kicked, and of bearing gratifying results to the kicker. Catering for ourselves and our followers also had to be attended to, and this sort of conversation would often ensue:—"Hassan, why have we no eggs in this camp when there is a village quite close?" "Ah, effendi, dey no buy (sell) eggs in dis village, all dee people want to make dee chickens."

To sleep during the mid-day rest was somewhat difficult. The temperature in the shade ranged from 100° to 115° Fahrenheit during the hot hours. There were also innumerable insects of various sorts in every camp. Ants of several kinds ran over us and bit us in the day time as well as at night. There were mosquitoes, sand flies and small biting beetles in most places, while huge hairy spiders and enormous hairless ones of ferocious attitude and powerful jaws often ran about inside our tents, but luckily these never preyed upon us. In one camp we were assailed by a whole army of little bees, which were extremely diligent in building small cocoon-shaped nests of mud in our bedding, boxes and clothes. At night the nests were tenanted by their builders, which resented a disturbance of their hardly-earned rest, and used their stings so freely that we were obliged to search carefully for the nests and burn out the defenders. Large black hornets were numerous, but inoffensive if not molested.

We yearned to catch and train one of the brilliant plumaged bee-eaters, of which there were four kinds in the country, to attend upon us and protect us from these noxious insects. A bee-eater fears no insect. I saw one of a small variety†† sitting on a twig suddenly dart into the air and catch a great hornet in the tip of its long bill. Returning to its perch with this delicate morsel, the bee-eater crushed it thoroughly by passing it to and fro through its beak and then suddenly swallowed it whole. In our camps furthest to the south white ants were a scourge and their ravages had to be carefully guarded against. All the baggage had to be moved and examined two or three times a day, and so quickly do these pests get to work that during a single night any article left lying on the ground will be completely covered with the sandy secretion, under which the ants operate, and will be half destroyed. Where these ants were numerous the trees were entirely brown with their workings, and the fallen trunks and boughs were not only brown with the protective covering but

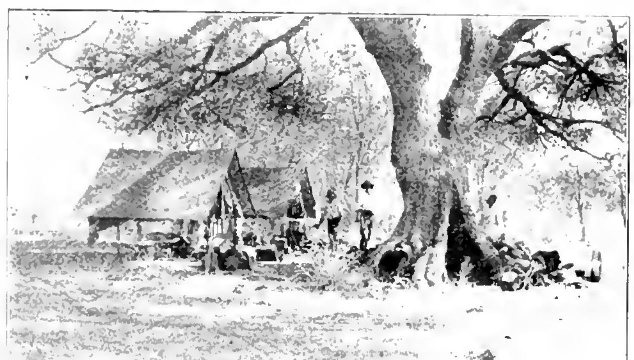


FIG. 2.—Camp at Gerazi.

eaten through, so that at every step on an apparent mound of earth one crushed through the shell of a fallen tree.

The most amusing visitors to our camp were the monkeys, which were numerous between Duem and Kawa. They were very tame and used to come regularly into the tree over the tents, and after a tremendous romp, would nestle up to each other and sleep for hours.

** *Anthus cervinus* (Pall.).

†† *Merops pusillus*, P. L. S. Mull.

They were grivet monkeys,[‡‡] of a beautiful greenish grey on the back, with whitish breasts, and black faces adorned with handsome white whiskers. We noticed that they were very fond of the gum which exuded from the acacia trees. But mammals of any kind were scarce in the country we worked, and we did not travel far enough south for big game. Occasionally a gazelle or an antelope would be seen, but they were rare and shy. In two or three places there were hares and it was while I was chasing a wounded hare through some rough grass that I came across the only bird new to science which we discovered. This was a tiny fantail warbler,[§§] of a most delicate light sandy colour on all the upper parts and with a silvery breast — a colouring most suitable for the brown grass and sandy country which it inhabited. I only obtained one specimen, and it is somewhat risky to found a new species on a single example, but the Hon. Charles Rothschild has lately obtained an exactly similar bird near Shendy, so that the claims of my new species may now be considered as established.

The photographs, with which this series of articles is illustrated, were taken by Mr. C. F. Camburn, to whom I am much indebted for permission to make use of them.

PLANT-BEARING HAIR

By R. Lydekker.

Although the name "sloth" is not unfrequently misapplied by travellers to the slow lemurs of India and the Malay countries, or to their cousins the galagos of Africa, it should, as many of my readers are doubtless aware, be restricted to certain peculiar mammals inhabiting the tropical forests of Central and South America. In addition to the simple character of their teeth, which are confined to the sides of the jaws, sloths are characterised by their short faces, rudimentary tails, shaggy coats, and hook-like claws by means of which they hang suspended, back downwards, from the branches of the trees among which their lives are spent. Two very distinct types of these animals are known, readily distinguished by the number of toes on the fore-limb. In the one form—the three-toed sloth—there are three claws on each foot, both in the front and the hind limbs. But in the other—the two-toed sloth—there are only two claws on each of the fore-feet.

These, however, are by no means the only differences between the two types (and I say types rather than species, because it is quite probable that each modification has more than a single specific representative). In the first place, there is a difference in the form and position of the first tooth in each jaw. In the three-toed sloth, or ai, for instance, this tooth is similar in form to those behind it, from the first of which it is separated by a space not longer than the one between the second and third. In the two-toed form, on the other hand, the first tooth is taller than those behind, and has a bevelled, instead of a flat grinding surface, while the space dividing it from the second much exceeds that between any of the others. Again, the front of the upper jaw of the two-toed sloth carries a T-shaped bone, corresponding to the premaxillæ of other mammals, which is totally wanting in the other form. The front of the lower jaw of the former is also prolonged so as to form a kind of spout, of which there is no trace in the latter. In both these respects the two-toed sloth comes much nearer to the extinct ground-sloth—of which we have lately heard so much—than is the case with its three-clawed cousin.

Again, if the males of the three-toed sloth be examined, there will be seen a patch in the middle of the back where, owing to the absence of the long coarse external hair, the presence of a soft orange and brown under-fur is shown. It has been stated that this patch of under-fur is made visible by the animals rubbing their backs against boughs and wearing off the long hair, but it seems much more probable that it is a sexual character. Of this under-fur the two-toed sloth has but a very imperfect development.

Apart from its extremely coarse and brittle nature, the most striking peculiarity of the outer hair of the sloths is its more or less decidedly green tinge. To see this in perfection it is necessary to examine living animals, as it tends to fade away more or less completely in skins which have been long exposed to the light, leaving the hair of a pale greyish brown colour. The green tint is, however, still distinctly visible in a pair of mounted specimens displayed to the public in the Natural History Branch of the British Museum.

Now green is a very rare colour among mammals, and there ought therefore to be some special reason for its development in the sloths. And, as a matter of fact, the means by which this coloration is produced is one of the most marvellous phenomena in the whole animal kingdom—so marvellous indeed that it is at first almost impossible to believe that it is true. The object of this peculiar type of coloration is, of course, to assimilate the animal to its leafy surroundings and thus to render it as inconspicuous as possible; and when hanging in its usual position from the under side of a bough, its long, coarse, and green-tinged hair is stated to render the sloth almost indistinguishable from the bunches of grey-green lichens among which it dwells. And if the physical means by which this green tinge in the hair of the sloths is produced be little short of marvellous, what is to be said with regard to the inducing cause of the phenomenon? But of this anon.

If a few hairs of the ai be examined under the microscope by a person familiar with the structure of hair in general, it will be found that while the central portion consists of what is technically known as cortex (and not of the medulla which forms the core of the hair of many mammals), the outer sheath is composed of an altogether peculiar structure, for which the somewhat cumbersome name of extra-cortex has been proposed. Possibly it may correspond to the thin cuticle of more ordinary hairs; possibly not—either way, it need not concern us further on this occasion. In old and worn hairs this outer sheath (as it will be more convenient to call it) becomes brittle and breaks away piecemeal, leaving the central core alone.

But in ordinary circumstances the sheath tends to form a number of transverse cracks, and in these cracks grows a primitive type of plant, namely, a one-celled alga.[*] And for the benefit of non-botanical readers it may be well to mention here that algæ (among which sea-weeds are included) form a group of flowerless plants related on the one hand to the funguses and on the other to the lichens. The majority live in water—

[‡‡] *Cercopithecus sabaeus* (Linn.). [§§] *Cisticola aridula*, Witherby.

[*] The presence of algæ in the hair of sloths has been long known to science, but the whole subject has recently been reinvestigated by Dr. W. G. Ridewood (*Quart. Journ. Microscopical Science*), and it is the appearance of his communication that has suggested the present article.

either salt or fresh—comparatively few deriving their nourishment from the moisture contained in the air. Some, indeed, are confined to particular descriptions of rock, and possess structures recalling roots, but even in these cases it is doubtful if they draw more than an insignificant fraction of their nutriment from the substance on which they grow.

In the moist tropical forests forming the home of the sloths the algæ in the cracks of their hairs grow readily, and thus communicate to the entire coat that general green tint, which, as already said, is reported to render them almost indistinguishable from the clusters of lichen among which they hang suspended.

"In thick transverse sections of the hair," writes Dr. Ridewood, "these algal bodies show up very clearly, since they stain deeply, and have a sharply defined circular or slightly oval outline. Unless the hair is much broken, they are confined to the outer parts of the extra-cortical layer."

Not the least curious phase of a marvellous subject is that the two-toed sloth, although the structure of its hair is very different from that of the aï, also has an alga, which belongs to a species quite distinct from the one found in the former.

In the two-toed sloth the hairs lack the outer sheath investing those of the aï, and consist chiefly of the central core of cortex; in other words, they correspond to those hairs of the latter from which the outer sheath has been shed. The surface of these hairs is distinctly furrowed with longitudinal grooves or channels, and it is in these channels that the alga distinctive of this particular species is lodged and flourishes. After stating that a solution capable of exhibiting the absorption bands of the vegetable colouring matter chlorophyll can be obtained from the hairs of this animal, Dr. Ridewood gives the following particulars with regard to their structure:—

"The hairs are, as a rule, coarse, and with a single curve extending over the greater part of the length, while the basal fourth or so is wavy; but in young specimens, and in some apparently adult examples from Costa Rica, the hair is very delicate and soft, and sinuous from base to point. However, in these forms the hairs . . . . have only two or three furrows instead of the more usual nine, ten, or eleven. The algæ, also, are quite absent from many of the grooves. When such an empty groove is examined in optical section it exhibits the outlines of obsolete extra-cortical cells. . . . . In baby specimens more than half of the hairs are slender non-medullate cylinders, with a very distinct scaly cuticle, and no grooves on the surface."

These simple hairs are, in fact, the only rudiments of an under-fur possessed by the two-toed sloth, or unau.

It may be added that in the presumably extinct ground-sloths (the skin of one of which has fortunately been preserved to us in a cave in Patagonia) the hairs are solid, without (according to Dr. Ridewood) any trace of the outer sheath of those of the aï, or of the flutings characterising those of the unau. These are thus evidently of a less specialised type than is the hairy covering of the modern tree sloths, as indeed would naturally be expected to be the case in the members of the ancestral group to which the latter probably trace their descent.

The above, then, are the essential facts with regard to the peculiarities of their hair by means of which the sloths are brought into such special and remarkable harmony with their environment, and it now remains to consider how best to explain their origin.

Of all the problems with which the naturalist has to deal those connected with the "mimicry" of one animal by another, or the special resemblances by certain animals to their inanimate surroundings, are some of the most difficult, and the present instance forms no exception to this rule, if it is believed that "natural selection," or some such mode of evolution, has been the sole factor in the case.

In this instance, at any rate, there can be no question as to any volition on the part of the animal concerned having aided in the development of its protective resemblance. And, on the hypothesis of natural selection, it appears necessary to assume that when the modern types of sloth were first evolved no alga grew in the hair of these animals, which were consequently able to exist and flourish without any such adventitious aid. The nature of their hair formed, however, in the case of each of the two groups, a convenient *nidus* for the lodgment and growth of an alga; and such a suitable situation was accordingly in each instance seized on as a habitat by one of those lowly plants. At first, of course, only a certain number of sloths would have had alga-producing hair, and these, from the green tinge of their coats, would consequently enjoy a better chance of escape from foes than would their brethren which had not yet acquired the greenish garb. And, on the assumption that alga-growing hair is inherited, their progeny would consequently have the best chance of winning in life's race. It is, of course, not difficult to assume that when the alga had once become firmly established as part and parcel of the hair of each group it acquired in both cases distinct specific characters, even if there were not originally two kinds of these plants concerned.

And here arises one of the many difficulties connected with this sort of explanation. It is quite clear that an alga would have been of no advantage to the sloths until they had acquired their present completely arboreal kind of life, and since there is a considerable probability that both types of these animals were independently derived from some of the smaller ground-sloths, it follows that on two separate occasions an alga has independently taken advantage of this suitable vacant situation and adapted itself to its new surroundings. This difficulty, like the one connected with sloths having flourished before they acquired a lichen-growth, may appear of little importance to those who are convinced of the all-sufficiency of natural selection, but to others it may (if well founded) seem more serious.

As we have already seen, the structure of the hair in the two types of sloth is, each in its own way, absolutely peculiar, and has therefore doubtless some special purpose. And, to put it shortly, the question consequently is whether these two types of hair structure were specially developed for the reception and growth of algæ designed to aid in the protection of the animals on which they occur, or whether such development has taken place for some totally different object, and that the subsequent growth of the algæ, and the additional protection thereby afforded, have been purely fortuitous. The fact that the hairs themselves assimilate the body of the sloth to a lichen-clad knot, shows that their peculiar character is largely protective, and it would be a most curious coincidence had this protective resemblance been enhanced by an accidental growth of algæ.

As regards the manner in which the growth of algæ is maintained in the sloths from one generation to another, the only rational explanation which presents itself is that the young sloths become infected with alga-spores from their parents. As already mentioned, Dr. Ridewood has pointed out that in very young individuals of the two-toed sloth a large proportion of the hairs are devoid of grooves; and it would therefore seem that the young sloths do not develop a growth of alga till about the time they are old enough to leave the maternal arms and hang independently on the leafy and lichen-clad boughs of their native forests.

THE TOTAL SOLAR ECLIPSE OF MAY 18, 1901.

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

The striking success which attended the observations of the eclipses of 1898 and 1900 has gone far to make people forget that conditions so favourable are very rarely obtained. On both occasions we had the shadow track passing for an immense distance through settled and civilized countries easily reached from abroad, and where all necessaries and conveniences could be readily procured. On both occasions, too, a great number of expeditions were organized, and many observing stations occupied, and everyone, without exception, enjoyed fine weather. This must be regarded as most phenomenal good fortune, which it was against every probability would be soon repeated. There is therefore no need to feel disappointed that the same unusual degree of success did not attend the eclipse of last May. It was one of specially long duration, but its geographical conditions were of the tantalizing character which are almost inseparable from such. The shadow track lay near the equator, and this being so, it was inevitable that much of it should lie across the open ocean or countries neither accessible nor civilized. Broadly speaking, only two limited regions were sufficiently accessible to tempt astronomers. For the eclipse at morning, the islands of Bourbon and Mauritius were available; whilst the west coast of Sumatra had it in the early afternoon. A French expedition, under M. Deslandres, went to Bourbon; whilst Mrs. Maunder and myself went to Mauritius. But the chief stream of observers flowed to Sumatra, attracted, no doubt, by the unusual length of totality there; and some eight or ten distinct expeditions, English, American, Dutch and Japanese took up their stations at Padang or within a few miles of it.

This limitation of observation to two very restricted areas stands in great contrast to the experiences of 1898 and 1900; but it cannot be doubted that it was imposed upon astronomers by the conditions of the case, and a similar limitation has been found imperative in the majority of eclipses.

As I have not yet had the opportunity, since my very recent return to England, of learning much as to the details of the results obtained by the numerous parties in Sumatra, I must restrict my present account entirely to the Mauritius observations.

From its situation, far out in the Indian Ocean, and nearly under the Tropic of Capricorn, Mauritius is in an extremely favourable position for the study of the great movements of the atmosphere. To the north of the island lies the equatorial belt of calms, with its hot damp and rarefied atmosphere; to the south, tropical calms characterized by their cool dry atmosphere and high barometric pressure. These two belts do not remain in a fixed position but move northward or southward with the sun. Mauritius therefore comes at one time of the year into the one belt, and six months later into the other, whilst for the greater part of the year the island lies in the track of the south-east trade winds. During the period that the sun is vertical, or nearly so, over the island, there is a liability to fierce cyclonic disturbance, the actual centre of which may or may not pass over the island, but the passage of which may make itself sensible even at the distance of hundreds of miles. Further, beside the observations which can be made on the island itself, it stands in the great highway from the Cape of Good Hope to India, a highway which was for long the chief route from England to India. It therefore was, and still is to some extent, a place of call for a large proportion of the vessels navigating the Indian Ocean, and the logs of the ships putting in here afford the means for ascertaining the general state of the weather over the entire ocean.

This favourable position drew the attention of a traveller, Mr. C. Meldrum, who half a century ago had the misfortune to be wrecked on Mauritius on a voyage from India to the Cape. From this time he made the

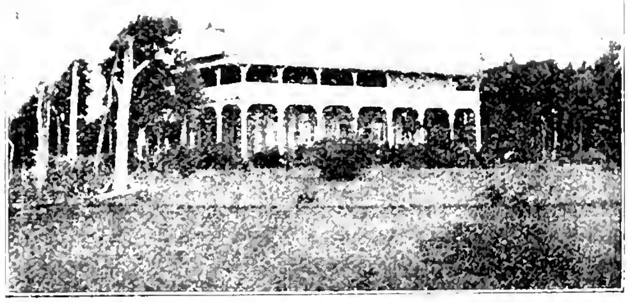


Fig. 1.—Royal Alfred Observatory, Mauritius. The group of trees on the left-hand side of the picture had to be cut down to a height of 16 feet in order to give a clear view of the Eclipse.

island his home, and the study of the atmospheric disturbances of the Indian Ocean his life work. He founded the Meteorological Society of Mauritius in 1853, and was for many years its secretary; he collected and copied the logs of as many of the vessels as called at Mauritius as he could obtain, he procured the establishment, first of a modest meteorological observatory in Port Louis, the capital, and later, as the value of his researches became better known and more appreciated, of a larger and more completely fitted one at Pamplemousses, some seven miles to the north. The foundation stone of this new institution was laid by H.R.H. Prince Alfred, Duke of Edinburgh, during his visit to the island in 1871, and it still bears his name.

The selection of Pamplemousses as the site of the new observatory has proved a most unfortunate one. This could not have been foreseen at the time when the erection of the observatory was resolved upon. Mauritius was then, except for a few sporadic cases, quite free from malarial fever, and the broad level plain not only offered a good horizon in almost every direction, but was the chief residential district of the island, and as it still is, the most fertile. But in 1867 there was a virulent outbreak of malaria, and before the Observatory was completed, it had become endemic in Pamplemousses, and the European population had been driven away and forced to seek refuge in the higher country on the further side of the capital, and the gateways of old country houses and widespreading yet crowded cemeteries alone remain to testify to the former popularity of the district.

The chief purpose of the observatory was, of course, meteorological; the study of the laws of storms, and the prediction of cyclones, the chief items in its programme. But astronomy was not neglected, and it was furnished with three instruments of respectable size and quality. These were a transit instrument of 3-inches aperture, an equatorial of 6-inches, and a photoheliograph of 4-inches. The existence of an observatory of this size and situated close to the very centre of the shadow track was a circumstance that could not be overlooked in the choice of stations from whence to observe the eclipse.

There was a yet further reason why the Astronomer Royal should have selected the Royal Alfred Observatory, Mauritius, as one of the stations to be occupied by one of the eclipse expeditions which he was sending out. The Director, Mr. T. F. Claxton, F.R.A.S., and his chief assistant, Mr. A. Walter, were both former members of the staff of the Royal Observatory, Greenwich, and an intimate connection has been kept up between the two observatories for the last seventeen years, in that the photographs of the sun taken at Mauritius, so far as they are required for the completion of the Greenwich series, are regularly sent to the latter observatory for measurement and reduction.

In coming to Mauritius, therefore, we came to friends and colleagues, who welcomed us as such, and who

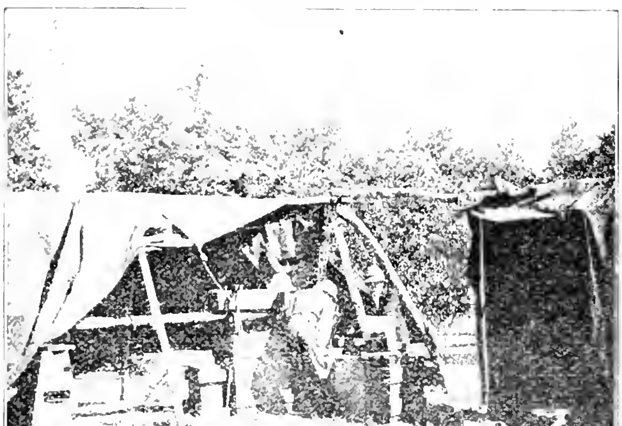


FIG. 2.—Mr. Claxton's Station at the Eclipse, showing the Mauritius Photoheliograph and the Rapid Rectilinear Camera mounted horizontally in connection with the 16-inch Cœlostat.

spared no trouble or pains to secure the success of our work. We reached the island on Saturday, April 20, and on the following Wednesday took up our residence at the Observatory, not without many warnings from Government officials, medical men and friends that we were doing a very risky thing. It was a risk, however, that we were obliged to face. We were bound to use to the uttermost the advantages offered by the instruments and buildings of the Observatory, so that we were precluded from seeking an eclipse station elsewhere in the island; and we could not make the Observatory our station unless it was to be also for the most part our home. For from the Observatory to the healthy country on the central plain of the island is a journey of more than two hours' length by road and rail, and the trains only run during the hours of daylight. If we had lived away from the Observatory, therefore, our working hours would have been very short, and it would have been impossible to make use of the stars for focussing and other adjustments of our instruments.

We were not at all inclined to regret this necessity

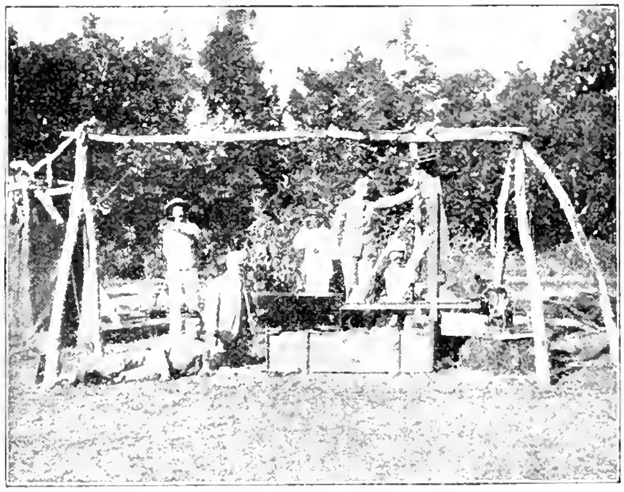


FIG. 3.—Mr. Maunder's Station at the Eclipse, showing the Greenwich Coronagraph and the Evershed Prismatic Camera mounted in connection with the 12-inch Cœlostat.

at first. The Observatory is a handsome building, standing in eleven acres of its own ground, and its surroundings are very pleasant to the eye. The climate was hot, damp and somewhat enervating, but being tempered by the breeze which sprang up every day soon after noon, was far from being unpleasant. A more serious drawback lay in the difficulty of getting sufficient manual assistance, though this was partly overcome by the kindness of the military authorities, who allowed five non-commissioned officers from the garrison who had volunteered for this work to come down for one day to unpack our instruments, and nine to assist us in the observations on the day of the eclipse. A yet further, and most important help was that one of these Staff-Sergt. Ralph Smith, A.O.C.—was allowed to place his services at our disposal pretty nearly continuously for the three weeks preceding the eclipse, and to his skilful hands we confided the care and treatment of the driving clocks of our telescopes and cœlostats.

The programme which Mr. Claxton and myself proposed to carry out in combination, comprised the photographing the corona with three instruments, all of the same aperture, but of very different construction and size of image, so as to secure delineations as perfectly as possible of its three chief regions. The photoheliograph of the Mauritius Observatory was the first of these, and gave an image of the sun nearly eight inches in diameter. With this instrument only the prominences and the very lowest region of the corona could be obtained. Next came the Greenwich coronagraph, giving an image $2\frac{1}{4}$-inches in diameter. With

NORTH

WEST

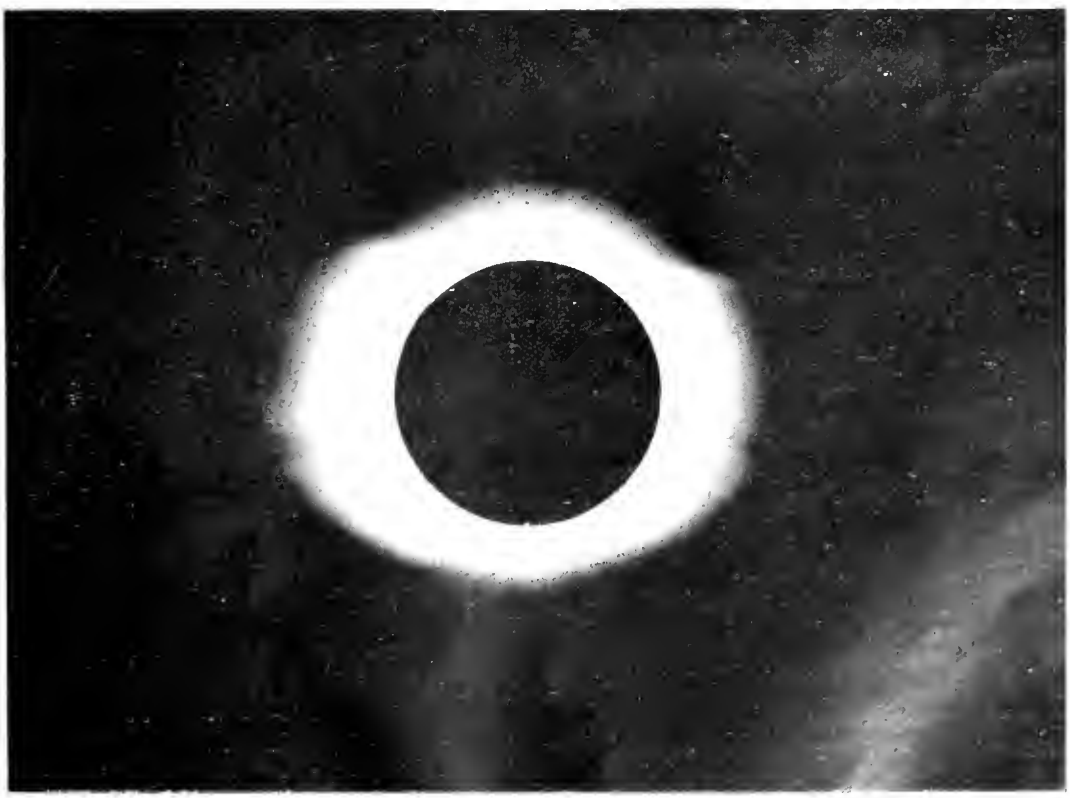
EAST

SOUTH

[illegible] 22 [illegible] Plate [illegible] Fine Grain

NORTH

WEST



EAST

SOUTH

[illegible]

THE CORONA OF 1901, MAY 18.

Photographed at the Royal Alfred Observatory Mauritius, with the Newbegin Telescope, 4 inch Cooke Photo visual Object Glass; Focal Length 71 inches

this the corona in general was sought to be secured, whilst with a Rapid Rectilinear lens by Dallmeyer, giving an image of 0·3-inches, the outermost extensions were aimed at. These three instruments, together with a prismatic camera, lent to the expedition by Mr. Evershed, were not pointed up to the sun but were mounted in a horizontal position, the light from the eclipse being reflected into them by means of a cœlostat. The Mauritius photoheliograph and the Rapid Rectilinear lens were mounted the one under the other in

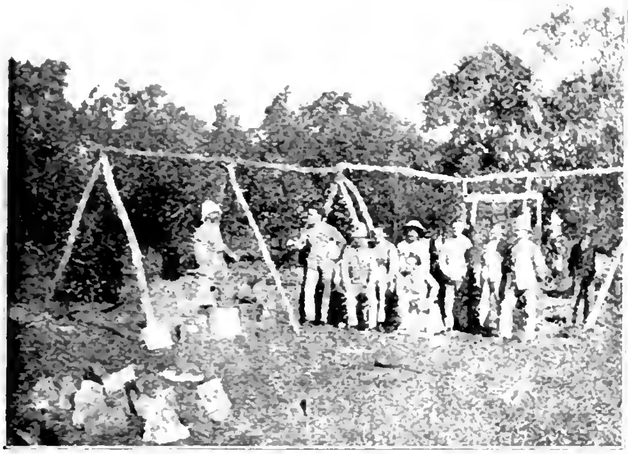


Fig. 4.—Our Military Helpers.

connection with one cœlostat, which had a mirror of 16 inches diameter, the prismatic camera and the Greenwich coronagraph in connection with a second, furnished with a 12-inch mirror.

Mrs. Maunder's programme and equipment were entirely independent of the foregoing. Her first purpose was to repeat with the same instruments the photographs obtained in India in 1898, and in Algiers in 1900, and she consequently brought the stigmatic lenses and the "Niblett" eclipse camera belonging to the British Astronomical Association which had been used on those occasions. The great kindness of Mr. Newbegin, F.R.A.S., furnished her also with the beautiful photo-visual telescope which Mr. Thwaites used in 1898 in India, and as its aperture was little over 4-inches, and the diameter of its image 2/3 of an inch, the photographs obtained with it supplement most usefully and instructively the threefold series of the official programme. The equatorial and camera bequeathed by the late Mr. Sidney Waters to the Royal Astronomical Society, and used in the last two eclipses, were also both part of Mrs. Maunder's equipment.

The weather on the morning of the eclipse was the most favourable of any morning since our arrival at Mauritius. A heavy bank of clouds did, indeed, hide the first contact from us, but this had passed and the light scud that followed it had also entirely cleared away before the eclipse became total. The sky was completely clear therefore during the fateful minutes, but not with anything like that purity and transparency with which we had been favoured on the two last occasions. Indeed, at Curepipe, some fifteen miles away, the whole spectacle was completely lost through cloud, and at Quatre Bornes, twelve or thirteen miles distant, a fine drizzle—locally known as "Moka dust"—fell during totality from a sky apparently clear, and gave to the fortunate watchers located there the unique spectacle of an eclipse [illegible] allow one to the corona and prominences.

This want of perfect clearness in the atmosphere is no doubt the reason for the following unmistakable result. It will be remembered that after our success with the little stigmatic lens in India in 1898, we set ourselves to ask the question as to whether the exposure of 20 seconds which we had then given was the longest which could be given with advantage. The answer in 1900 was that an exposure of 18 seconds had no advantage as to length of coronal streamers shown over an exposure one-sixteenth that duration. The answer to the same question as asked in Mauritius was more decisive still in the same direction. The longest streamers that we obtained were due to the Newbegin telescope, and correspond to about a second's exposure with the stigmatic lens. This result is not the one we should have liked to have got, but a result is always worth getting whether it accord with one's predilections or not. The result we obtained is not the solution of the problem as to whether the actual length of the coronal streamers varies from eclipse to eclipse, but only that, for this eclipse, our longest exposures exceeded that of greatest efficiency under the actual atmospheric conditions.

As a series the finest set of photographs we obtained were the fourteen taken by Mr. A. Walter during totality with the Newbegin telescope, two of which are reproduced in the accompanying plate. It is sufficiently well known that the corona is by far the most difficult object for photographic reproduction, and any photomechanical process such as that employed for the plates in Knowledge necessarily fails to do more than exhibit the general distribution of light in the corona; its delicate details completely elude representation. Yet full as the original photographs are of beautiful detail, and as pictures of the lower corona, I do not think that finer photographs than these and some of those taken with the Greenwich coronagraph have ever been obtained. The corona, as a whole, must be pronounced as

Fig. 7.—Photograph of the Partial Phase, taken in Port Louis Harbour by the Chief Officer of the s.s. "Regina."

distinctly simpler than that of last year; it is of a yet more pronounced minimum type. It is confined even more strictly to the four same regions; the east and west equatorial wings parallel to the equator, and the groups of radiating plumes round the north and south poles. But the equatorial extensions are even more strictly than in 1900, parallel to the equator, and the polar plumes are fewer and more distinct.

It is no good quarrelling with a minimum corona because it is a minimum corona; we have to accept the fact that it is of a comparatively simple structure and learn the lessons which that fact has to teach.

Yet even this corona, at a time of almost utter sun-spot stagnation, shows, though more feebly than the two preceding eclipses, the synclinal curves rising from the prominence regions and terminating in narrow rod-like rays. And as in 1900, the corona is still invaded by what would appear to be "dark rays," though these are less clearly distinguishable from mere rifts than in that eclipse.

Upon the more routine observations it is not necessary now to enlarge. The times of the second, third and fourth contacts were successfully determined by three independent observers at the Observatory, and by a fourth, Capt. Robertson, of the British India s.s. "Ugina," at Port Louis, to whom we are indebted for the accompanying photograph of the partial phase taken by his chief officer from the deck of the vessel. Mr. Claxton also took a very fine series of thirty-four photographs of the partial phase with the Mauritius photoheliograph on a scale of eight inches, for the moon's diameter and place. And the list of photographs may be concluded by one which, though of no scientific value, is certainly unique, namely, a photograph of the corona taken with a pinhole camera belonging to Mrs. Maunder, aperture 1/32 of an inch, focus 33 inches, and exposure $3\frac{1}{2}$ minutes on an Imperial Special Rapid plate.

CONSTELLATION STUDIES.

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

IX.—THE SEA-MONSTER AND THE FLOOD.

In our Constellation Study for June, I drew attention to the familiar fact that so many of the forms of the primitive constellations are duplicated, and that when thus repeated, the twin symbols are, as a rule, not widely separated, but placed close together. The bird region on the Milky Way is a remarkable instance of this. But a still more striking one is found in the portion of the heavens which we have now reached. We are in the midst of the signs of fish and water.

The first token of these marine symbols occurs in the pretty little constellation of the Dolphin that coils itself behind the outstretched wing of the Eagle. Then follows the fishtail of Capricorn. Next we have Aquarius, with the broad stream flowing from his ewer, and the Southern Fish at his feet. Aquarius is succeeded on the Ecliptic by the long constellation of Pisces, a pair of fishes united by a waving riband. Below this group two other constellations repeat in more terrible form the design of the water-pot of Aquarius. A huge marine dragon known to us to-day as Cetus, the "Whale," but traditionally rather of saurian form, like the

"Monstrous eft that of old was lord and master of earth,"

pours forth from his mouth a vast bifurcating flood, which sweeps down below the horizon.

It is impossible to suppose that the association of these seven watery constellations in such close connection with each other can possibly be accidental. We may dismiss at once the idea that they have any special reference to the rainy season, for an eighth water constellation is supplied us in Hydra, the Water Snake, which, with the seven just named, very nearly completes the circuit of the sky. We should therefore have to conclude that we were dealing with a climate which was rainy throughout the year, a circumstance not likely to be symbolized in this particular fashion.

Anything like an adequate discussion of the true significance of this grouping would lead us too far astray from our present purpose. Greek mythology saw in Cetus the monster which Neptune sent to destroy Andromeda, in punishment for the pride and insolence of her mother Cassiopeia, and this, of course, is the account of Aratus.

> "Mark where the savage Cetus, crouching, eyes
> Andromeda, secure in northern skies;
> The Fish and horned Ram his progress bar,
> Nor dares he pass the track of Phœbus' car."

Brown identifies Cetus with the Euphratean Tiamat, the spirit of Chaos, the enemy of the beneficent gods, and opposed to law and order; and he notes that the southern heavens are generally given over to creatures of like ill significance—Hydra, Scorpio, Lupus, Corvus, Canis—representing, with Cetus, perhaps six of the "Seven Evil Spirits" of Akkadian mythology.

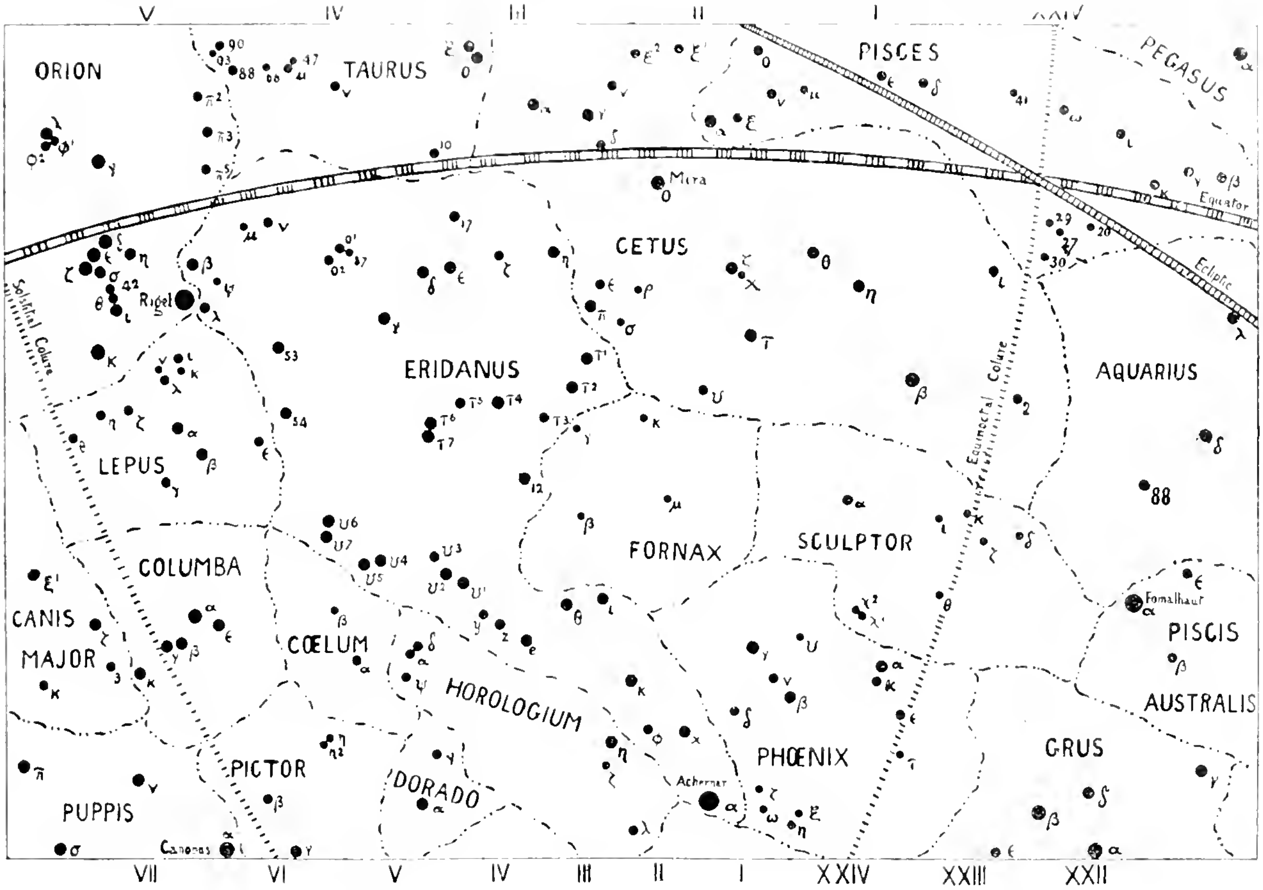
To the eye, the principal stars of Cetus form the outline of a lounge chair, spreading over a vast expanse of sky, its length being 50°, its average breadth 25°. Though none of its stars are bright, Beta only being of the second magnitude, and Alpha about $2\frac{1}{2}$, the general outline can be pretty easily followed. Proceeding from east to west, Kappa, Alpha, Gamma, Delta and Omicron mark out the headrest of the lounge chair, or if we prefer so to speak of it, the lower jaw of the monster. The body of the chair is carried on by Theta and Eta, whence the axis of the constellation curves down to Beta, the footrest of the chair, or the tail of the beast. The back leg of the chair is marked by Epsilon and Pi, in a straight line with Omicron; whilst Zeta, Tau and Upsilon, springing from Omicron in a graceful curve, mark the front leg. Only a few of the stars have distinctive names in common use at present. Alpha is known inappropriately as Menkar, the "Snout," as the title more strictly belongs to Lambda, the fifth magnitude star above it. Beta is Diphda, the "Frog," its full name being Diphda al Tania, the "Second Frog," the first being Fomalhaut. These two stars were grouped together by Aratus as well as by the Arabs.

> "The southern Fish beneath Aquarius glides,
> And upwards turns to Cetus' scaly sides.
> Rolls from Aquarius' vase a limpid stream
> Where numerous stars like sparkling bubbles gleam;
> But two alone beyond the others shine;
> This on the Fish's jaw—that on the Monster's spine."

The star of Cetus is Omicron; its title of Mira, "Wonderful," being justly given to it because of its remarkable variations. It does not occur in Ptolemy's Catalogue, and the first recorded observation took place in 1596, when David Fabricius observed it as a third magnitude star. At its minimum it entirely disappears from the unaided sight, its brightness sinking down in the extreme case as low as magnitude $9\frac{1}{2}$. Its maximum is usually about that of the third magnitude, but it has been known almost to equal Aldebaran. Its period of variation occupies eleven months, for about half of which it is invisible to the naked eye. Under ordinary circumstances, therefore, its brightness at maximum is four hundred times that at minimum half a year earlier; whilst its extreme range of brightness is four times as great as this. Such a variation still baffles our every attempt to account for it satisfactorily; the explanation which obtains most currency, namely, that Mira is a dying sun, the surface of which from time to time is nearly hidden by enormous sunspots, is but a crude guess which leaves us still with many difficulties. It is certain that a variation in the case of our sun of but a tithe the amount of Mira's would leave this earth as bare of life as a meteorite, ere it had passed through a single course of its changes. Yet Mira is but the chief and representative of a large class of variable stars.

from the attack of the monster Typhon, clearly only an imperfect Greek rendering of an Euphratean tradition. The doubling of the fishes is supposed by Sayce but manifestly without due cause, to be due to the double month Adar, that is to say, Adar with the intercalary month Ve-adar. The constellations must have been, and were, mapped out long before the division of the zodiac into the twelve equal signs of 30° each, associated with the months.

Although Pisces is a particularly dull constellation to the naked eye, its two brightest stars, Eta and Gamma,



Star Map No. 9: The Region of the Sea-Monster and the Flood.

The idea of Cetus as the persecutor of Andromeda is carried out on our modern star atlases by the intervention of the zodiacal constellation of the Fishes, and indeed the arrangement is warranted by the description which Aratus has given us in his poem:—

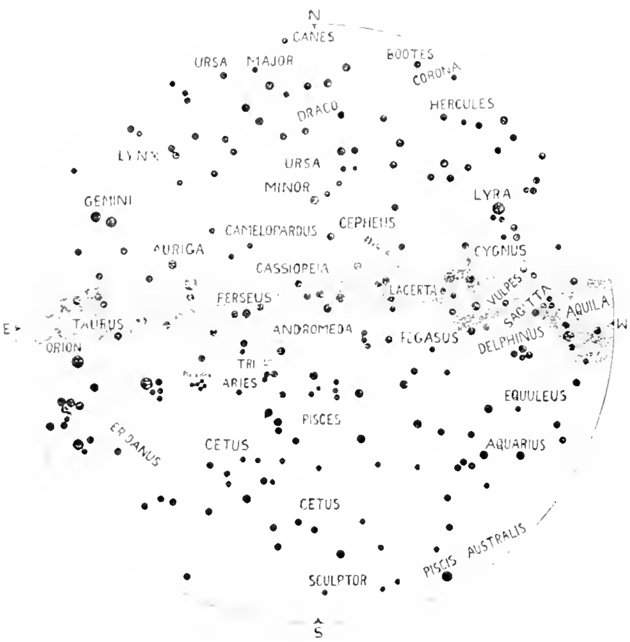
> "Where the equator cuts the zodiac line
> On the blue vault, the glittering Fishes shine
> Though far apart, a diamond studded chain,
> Clasping their silver tails, unites the twain.
> The northern one more height is seen to glide
> Beneath the uplifted arm and near the side
> Of fair Andromeda."

The knot of the riband actually rests on the neck of the Sea-Monster, and as the riband stretches northward to the Northern Fish, the latter is often represented as playing the part of Cetus, and actually fastening on the side of his devoted victim, who might otherwise have smiled securely at the distant hate of the Sea-Monster. There does not appear, however, to be any sufficient traditional authority for this relationship. The classical legends identify the twin fishes with Aphrodite and Eros, who plunged into the Euphrates to escape

barely surpassing the fourth magnitude, it is an easy constellation to trace out, as it consists chiefly of a number of stars between the fourth and fifth magnitudes, arranged in two obvious streams. Alpha, the most easterly star of the constellation, is not far from Mira Ceti, and marks the knot where the two cords attached to the tails of the two fishes are tied. This is implied by its name Okda, from Okda al Kaitain, the "knot of the two threads."

> "The silken bands that join the Fishes' tails
> Meet in a star upon the Monster's scales
> Beneath Orion's foot Eridanus begins
> His winding course, and reaches Cetus' fins."

The constellation of the Stream is a large but not specially well marked one. Aratus and Eratosthenes give it the name "Eridanus," and it seems extremely probable that the Akkadian identified it with the Euphrates as the Egyptians with the Nile. Brown considers that the name "Eridanus" may be a Turanian river name, meaning "strong river." The meaning of the placing of the river in this part of the heavens is not apparent at first sight, since the story of Perseus and Andromeda, with which the Sea-Monster is connected, gives no record of a stream or river, unless we consider that the constellation refers to the flood, to cause the abatement of which Andromeda was sacrificed. If this be so, then no doubt Eridanus stands for the Great Deep of the Primeval Chaos of which the Sea-Monster typified the indwelling principle. Proctor has seen in the constellations surrounding Ara a note of the Hebrew account of the great Deluge, and it is



The Midnight Sky for London, 1901, October 1.

possible that in this flood of Eridanus which the Sea-Monster pours forth from his mouth, there may equally be a reminiscence of the same great flood which figures so largely in Babylonian tradition.

Only two of the stars of the constellation bear special names in common use to-day. Alpha Eridani, a bright star far below our English horizon, is now known as Achernar, meaning "the end of the river." In Ptolemy's Catalogue the star with the corresponding title is our Theta, a star some 17° further north. But apparently it was felt the constellation lost its meaning unless it was prolonged downwards to the horizon, and hence as new stars came into view with southern exploration, the constellation was prolonged to within 32° of the southern pole. Beta Eridani, the brightest star in the part of the constellation familiar to us, and close to Rigel, the bright star on Orion's knee, is sometimes known as Cursa, the "footstool" or "throne" of Orion.

Obituary.

PROFESSOR BARON VON NORDENSKJOLD.

Professor Baron Adolf Erik von Nordenskjöld, the celebrated Arctic explorer, died very suddenly—he was in fact working in his laboratory on the day of his death—on August 12th last. Nordenskjöld was born on November 18th, 1832, at Helsingfors, the capital of Finland, where his Swedish ancestors had settled. His father, Nils Gustav Nordenskjöld, was a distinguished mineralogist, and it was probably during expeditions with his father to the Ural mountains and other regions that young Nordenskjöld first acquired his taste for travel, as well as for mineralogy. In 1849 he entered the university of Helsingfors, devoting himself chiefly to the study of mineralogy and geology. His political views being considered as unorthodox by the Russian authorities, he was forced to leave Finland, and in 1857 settled at Stockholm, but was permitted to return to Helsingfors in 1862. In 1858 he first visited the Polar regions, accompanying Torrell, as geologist, to Spitzbergen. In 1861 he again visited Spitzbergen with Torrell, while 1864 found him once more in that arctic island, the southern portion of which he mapped as well as completing the preliminary part of a survey for the measurement of an arc of meridian. His first expedition on a large scale was undertaken in the *Sofia* in 1868, when the high latitude of 81° 42′ N. was reached. Mr. Oscar Dickson, whose name has been always associated with that of Nordenskjöld as providing the funds for his most important expeditions, determined on a new expedition, which was to winter on the south-east coast of Spitzbergen, and thence to push north in sledges over the ice. With this in view the explorer proceeded to Greenland in 1870 with the object of testing and comparing the utility of dogs and reindeer as beasts of traction. In 1872 the new polar expedition at length started, but the ice conditions were extraordinarily unfavourable, the reindeer—chosen in preference to dogs—escaped, and Nordenskjöld was further handicapped by having the crews of some frozen-in walrus sloops depending upon him for subsistence. However, some good scientific work was done, and extensive journeys made over the inland ice of North-east Land. Nothing daunted by this failure, the explorer, with the help of Mr. Dickson, worked for the next few years on the exploration of the Siberian Polar seas. This work culminated in his world-renowned voyage in the *Vega*, when the north-east passage was first accomplished. Starting from Tromsö on July 21st, 1878, the *Vega*, accompanied by the *Lena*, passed through the Kara Sea, and on August 19th, rounded Cape Cheliuskin, the northernmost point of Asia. At the Lena delta the *Vega* parted company with her consort, which sailed up the mighty river, the name of which she bore. Proceeding slowly through increasing masses of ice the *Vega* continued her voyage alone, and was eventually icebound at the end of September off Pitlekai in 67° 07′ N., 123° E. During the long winter and spring the explorers carried on scientific observations, and it was not until July 18th, 1879, after 294 days' imprisonment, that they were again able to weigh anchor. Two days later the eastern extremity of Asia was rounded, and, proceeding down the straits, Yokohama was reached on September 2nd. On his return to Europe Nordenskjöld was greeted with the utmost enthusiasm. He was created a Baron in the Swedish Peerage, and many other honours, which the successful accomplishment of his adventurous voyage deserved, were bestowed upon him. In 1883 he undertook a second expedition to Greenland, after which he devoted himself to the study of Antarctic exploration. Although advancing years precluded him from visiting these regions himself, it must have been highly satisfactory to him to know that his nephew—Dr. Otto Nordenskjold—was about to lead an expedition to the Antarctic regions. Besides the explorations for which he is chiefly famed, Baron Nordenskjöld's researches in mineralogy and geology were important, and he sat as a Liberal for many years in the Lower House of the Swedish Diet.

Letters.

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

THE DISTRIBUTION OF THE STARS IN SPACE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I have just been reading the able article on "The Brightness of Starlight" in the August number of Knowledge (by J. E. Gore, F.R.A.S.), and have been particularly struck with the very discordant results there obtained, by making use of Dr. Gould's formula, and the method adopted by Mr. Gore.

Now this subject of the Distribution of the Stars in Space is one that I have often thought about. I do not refer so much to the distribution of the stars according to "magnitude," as according to their actual "position" in space. Has anything yet been done towards the solution of this question, or if not, have data sufficient for dealing with the subject yet been accumulated?

I have a notion that some light may be thrown on the vast subject of "The Evolution of the Galaxy" by this means; and especially, may I add, by concentrating attention on the comparative sparseness or closeness of the stars at different depths, along the great circle of the galaxy. Arthur Ed. Mitchell.

Oxenhope, nr. Keighley.

[The investigation of the comparative numbers of stars in different directions in space, by means of "star gauges," presents little difficulty, but to determine in addition the relative numbers at different distances is a problem which cannot at present be completely dealt with, because of the want of data as to the distances of a sufficient number of stars. Actual measurements of stellar parallax are very few, and magnitude is no safe guide to stellar distance, so that we must needs make the best we can of proper motions as a key to the distances of the stars, the stars with large proper motions being supposed relatively near. Even with this basis, however, the distribution of only a few thousands of stars can at present be discussed; certainly not enough in themselves to indicate the form of our stellar universe. Evidence as to the construction of the heavens is, therefore, mainly indirect, and hence the many different views on the subject. Still, one fairly definite result arrived at by Prof. Kapteyn from a discussion of proper motions is that the sun is a member of a cluster of stars of the same type as itself, and that a denser ring of white stars, situated at a great distance outside this cluster, appears to us as the Milky Way.—Eds.]

SUDDEN BLANCHING OF HUMAN HAIR.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In his paper on the whitening of the hair of animals, Mr. Lyddeker remarks that, from the evidence, the fact of rapid blanching of human hair from emotion must be accepted. It may interest him and some of your readers to know of a definite instance of this effect, not from emotion, but from disease. I have recorded it where it is not likely to be generally accessible ("Man. Dis. Nerv. Syst.," Vol. II.). A man, in consequence of an injury, had hæmorrhage over the greater part of the left hemisphere of the brain. During the next two days the hairs of his beard and moustache on the opposite side, the right, were observed to become paler and paler, until they were almost white at the time of his death on the third day. The change extended up to the middle line and there ceased. A very curious fact is that the pale region was separated from the normal brown, by a very narrow darker zone, almost black, in the middle line. Of course emotion must act by its profound derangement of the function of the cortex of the brain. Here we had a like effect produced by an organic influence, occurring under observation within two days, and limited to the opposite side that which the disease would influence. The escape of the hair of the scalp, and affection of that of the face, may be ascribed to the special seat of the chief cerebral irritation. The hairs were made pale throughout their length. This, as an absolute fact, a result produced in two days, is significant. The only possible explanation is that the process, at the root of the hair, by which the normal pigment is produced, is so changed that a material is formed capable of discharging the colour of the pigment, and that this ascends the tubular hair and causes its effect, at least as far from the root as the length of the hairs on the face. The degree to which this chemical process is under the influence of the nervous system is strikingly obvious, but a similar action is treated on most of the secretory processes of the body. Tears are an illustration.

The dark line which limited the change is not easy to explain. We know that pigment is apt to accumulate at the limit of an area in which it is lessened, but we can hardly apply here the idea of any movement of pigment. It would rather seem as though, at the median line, at which the innervation of the two sides mingle, the defective influence of the one side, in some way, permitted that of the other side to become excessive. There are curious conditions yet to be worked out regarding the median blending of the nerve influence. In the lower part of the face the zone of coalescence is more considerable in extent and degree than in many other regions. W. R. Gowers, M.D.

A TRIPLE RAINBOW.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The remarks of your correspondent in the last issue of Knowledge on the subject of rainbows, recalled to my mind a very remarkable triple rainbow that was seen at Sutton-on-Sea on the 13th August at 4.20 p.m. A terrific hailstorm, accompanied by thunder and lightning, was in progress. In the direction of Louth and Grimolaby, the sun was shining through a cloudless sky, but, due west of Sutton, at an elevation of some forty-five degrees above the horizon, was a magnificent and well defined rainbow, whilst immediately underneath it, as it were, was another, which was not so intense or bright. A third was faintly visible underneath the last-mentioned, the distance separating the three being some 2½°. It seemed to me that there was more than one storm in progress at the time. C. McKenzie Knight.

13, Millman Street, W.C.

MOTHING IN SUFFOLK.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Take it altogether, August is generally my best month with lepidoptera, and I was not disappointed this year at Benacre, near Wrentham, in Suffolk. The commoner butterflies were revelling in the bright sunshine. Peacocks were numerous, and I was fortunate enough to take one with the small blue spot under the eye-like mark in the hind wings. I may be wrong, but I flatter myself that I was the first to discover this variety of Io. I saw no clouded yellows in either clover or lucerne, and although I am told of good takes this year at Sheerness, especially of *hyale*, the pale species, I think it unlikely we should have two clouded yellow years in succession. One hairstreak (*T. quercus*) about completes my list of rhopalocera. With the *sphingidæ* I had a good time. It was a grand sight to see the huge convolvulus-hawk moths darting round and about the tobacco plants at dusk. Five or six were often there together humming like a hive of bees. They first appeared on the 20th, and kept it up all through the month. The females, though decidedly inferior in markings and antennæ, were always the largest, measuring some five inches from tip to tip. The specimens I took are so perfect that it is difficult to believe they are not home-bred. So far the moths of this species taken in Great Britain have been considered to be foreign-bred, but I have just examined a live pupa of *S. convolvuli*, in the possession of Mr. F. W. Frohawk, which is evidently a genuine specimen. The long trunk of the imago is very conspicuous in this pupa. This is, I believe, the first authenticated pupa of the convolvulus-hawk moth taken in Great Britain, though I have read in the *Field* and elsewhere of several reported takes of the larvæ. As regards the perfect insects we soon ceased taking them, yet they gradually diminished in numbers, and now I hear there are none; but according to my experience of their habits, they will assemble again at Benacre, in full force, about October. *Atropos* (death's head) larvæ were brought to me frequently, dug up while pulling potatoes. They are addicted to burrowing during the day, long before the final burial. Hence should be sought for at night, with a lantern, when they have emerged for a feed. It is curious what a large air-chamber this caterpillar makes under ground, in which to perform its two great transformations. If they are dug up it is better to force the pupæ in damp moss, and in a warm room, or otherwise they rarely survive the winter. I took both larva and imago of privet-hawk, also the larva of the eyed-hawk on an old willow. The beautiful little humming-bird moth was decidedly scarce this year, though it is generally a feature in the well-stocked Benacre gardens. Leaving the hawk-moths I come to the handsome tiger, drinker, and oak-egger, all of which my caddies brought me on the Southwold Golf Links. At light I took two species of thorn, viz., canary-shouldered and early. In a cover by the sea I took a perfect specimen of a female black arches, asleep on the trunk of a gigantic oak. Some years ago I took a male in the same locality. At sugar, red underwings appeared early, viz., 16th, but were never numerous. My great take was *C. fraxini* (Clifden nonpareil) on sugar on the 24th August. In my excitement in taking it I chipped the tip of the right upper wing. Otherwise it is a perfect specimen of this rare moth. With the lamp turned on, it showed to the full its grand expanse of upper, and gorgeous colouring of lower, wings, and it was a sight I shall not easily forget. For toads, hornets and wasps I was fully prepared, but a full-fed larva of the goat-moth on the sugar seemed to me out of place. Jos. F. Green.

Blackheath.

SUNSPOTS AND LIGHT.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In the *Proceedings* of the Royal Society, No. 446, page 295, Dr. W. J. S. Lockyer makes the following statement:—"It is generally conceded that the spots on the surface of the sun are the result of greater activity in the circulation of the solar atmosphere, and therefore indicate greater *heat* and, therefore, *light*. This being so, the curve representing the spotted area may be regarded as a light curve of the sun." I thing this statement is not quite correct. *Greater heat* may not imply more light, above a certain temperature the reverse is the case. Gas in an ordinary jet gives light; in the flame from a Bunsen burner, or in the cone from a blow-pipe, we have much greater heat and very little light. The flame of a spirit lamp gives greater heat than a candle, but it gives very little light. I think the sentence should read, "greater heat and, therefore, *less* light." Certainly the spots are much darker than the photosphere. Notwithstanding this, the analogy between the two curves may hold good with a different explanation. For similar reasons we need not regard the brightest stars as the *hottest*, probably the reverse is the case. A. Elvins.

Toronto.

[Mr. Elvins raises questions which would take no small space for their discussion. It may certainly be granted that the sentence which he has quoted is, when taken by itself as it stands, extremely crude. We are not yet in a position to state unfalteringly that the sun gives most light at the sunspot maximum, or that its light varies with the spot curve. On the other hand, it is of course generally true that increase of heat means increase of light, the instances Mr. Elvins mentions notwithstanding. In the case of the sun, and we infer in the case of the stars likewise, the light proceeds for the most part from the photosphere, and this is considered to be a condensation surface. We might consider then that an increase of temperature would diminish the amount of condensation and so lessen the amount of light radiated. But it seems more probable that the actual effect would be simply to raise the level at which condensation took place, and therefore to form a greater radiating surface and one less affected by absorption from the sun's immediate surroundings; in other words, we should have an increase in the light. In the case of stars the brightness is obviously no guide to their temperature, since their brightness depends, among other things, on their distance. The relative temperatures of stars are therefore determined by comparing the intensities of their spectra in the violet and ultra-violet, not by comparing their stellar magnitude. —E. Walter Maunder.]

Notices of Books.

"Star Atlas, with Explanatory Text." By Dr. Hermann J. Klein. Translated by Edmund McClure, M.A., M.R.I.A., F.L.S. (S.P.C.K.) Price 10s.—This excellent atlas of the stars is too well known to need extended notice. In the present edition the text has been revised and considerably enlarged, and the positions of the stars have been corrected to 1900. The notation for nebulæ now includes that of the New General Catalogue, as well as that of Herschel. For the benefit of readers as yet unacquainted with the atlas we may add that the maps cover the heavens from the north pole to declination 34 degs. south, and include all stars down to magnitude 6.5, as well as the principal clusters and nebulæ, while the text consists of useful notes on the various objects of interest which come within the range of moderate telescopes. Besides the star maps there are a number of views of clusters and nebulæ, but some of these might with advantage have been copied from photographs instead of from old drawings. While regretting that all reference to the Milky Way is omitted, both in maps and text, we cordially recommend the atlas to those desiring a trustworthy guide to an intimate acquaintance with the stars.

"Astronomischer Jahresbericht." Edited by Walter F. Wislicenus. Vol. II. 1900. Published with the aid of the Astronomische Gesellschaft. (Berlin: Georg Reimer. 1901.) Pp. xxvi. and 657. The second volume of this most useful publication, which aims at giving a brief account of every astronomical book, article, or paper published in 1900, deserves the highest praise. No branch of astronomy is neglected, and every work published in a European language seems to have been included. The excellent classification of subjects, together with an index of names, makes it easy for the reader to find the literature relating to any branch of the science in which he may be interested, and the abstracts furnished give just enough information to enable him to judge of the importance of any particular contributions. Observations of comets and minor planets are brought together in a convenient form. The present collection of references and notes differs from those provided by our various journals inasmuch as it contains all contributions to the literature of astronomy, and not simply a selected few, for notice, and, moreover, the work is much handier for purposes of reference. The editor, who appears to be himself responsible for the greater part of the volume, has done his work well and impartially, and deserves the thanks of all who are interested in the progress of astronomy. A copy of the book should find a place in every observatory and astronomical library.

"Plant Studies. An Elementary Botany." By John M. Coulter, A.M., PH.D., University of Chicago. (Kimpton.) Illustrated. 7s. 6d. net. If the whole of the "nearly one hundred volumes" of the Twentieth Century Text Books which (as we are informed) it is intended to issue, are as interesting and beautifully illustrated as the present little book, we shall certainly welcome their appearance. The work does not consist of altogether original matter; portions of the author's "Plant Relations" and of his "Plant Structures" have been worked up and combined with new material; the result is a highly readable school text-book of botany viewed from an ecological and morphological standpoint, the letterpress simple and essentially practical, the illustrations numerous and instructive. Beginning with the leaves, the light relation is considered first, and subsequently their functions and structure. The remaining portions of the plant having been similarly dealt with, the plant in all its relations is considered, especial attention being drawn to the struggle for existence, and the question of food-supply. This leads to the consideration (in four chapters) of plant societies, a subject wisely elucidated by a wealth of illustrations from nature. Thence we pass to the great groups of the plant world: these are treated in a broad general way suitable to the limitation of space which necessarily pertains to a book of the kind. We cordially recommend Prof. Coulter's "Plant Studies" to our readers.

"Poisonous Plants in Field and Garden." By Rev. Professor G. Henslow, M.A., etc. (S.P.C.K.) 2s. 6d. The object of this little book is "to enumerate and describe such of our common wild plants, as well as some frequently cultivated, which are at all likely to prove harmful to our little ones; who are only too apt to put everything which appears attractive into their mouths." But it is pointed out at once that many cases of plant poisoning are due, not to the irresponsible acts of children, but to the deliberate but mistaken action of adults; and to the latter the book is properly addressed. Following some preliminary ready remedies for poisoning, we find a chapter devoted to the structure of flowers and fruits, and another on the principles of botanical classification and nomenclature, to assist the unbotanical reader in the understanding of what follows. The remainder of the book is taken up with brief descriptions of the commoner hurtful plants arranged in the natural order, with a good deal of information concerning their poisonous properties, not unmixed with lore from the old herbalists, and occasional antidotes. Numerous cases of poisoning are described, forming reading which is sufficiently terrifying; and the prudent resolution of the average reader will, we fancy, be to try no experiments and eat no vegetables but what he buys at his greengrocer's. The illustrations, which are numerous, are mainly drawn from Bentham's "Handbook of the British Flora"; while conveying a general idea of the plants described, they would be but little use in assisting the non-scientific reader to distinguish poisonous from non-poisonous species.

BOOKS RECEIVED.

Treatise on Zoology. Edited by E. R. Lankester, M.A., LL.D., F.R.S. Part IV. The Platyhelmia, Mesozoa, and Nemertini. By W. Blaxland Benham, D.SC. (LOND.), M.A. (OXON.). (Black.) Illustrated. 15s. net.

Use-Inheritance. By Walter Kidd, M.D., F.Z.S. (Black.) Illustrated. 2s. 6d. net.

Practical Mathematics for Beginners. By Frank Castle, M.I.M.E. (Macmillan.) 2s. 6d.

Plane Geometrical Drawing. By R. C. Fawdry, M.A. (Spon.) 3s. net.

Land and Fresh Water Shells. By J. W. Williams, M.R.C.S. (ENG.), F.L.S., F.R.M.S. (Swan Sonnenschein & Co.) Illustrated. 1s.

Clinical Pathology and Practical Morbid Histology. By T. Strangeways Pigg, M.A. (Strangeways & Sons.) 5s. net.

The Oxford and Cambridge History of England. By Roscoe Mongan, B.A. (Gill.) Illustrated. 1s.

Cowper's "Expostulation." With Notes by J. Knowles Caldwell, M.A. (Gill.) 1s.

Notes on Agricultural Analyses. By T. S. Dymond, F.I.C., and F. Hughes. (Chelmsford: County Technical Laboratories.)

The Evolution of Sex. By Prof. Patrick Geddes and Prof. J. Arthur Thomson. (Scott.) Illustrated. 6s.

Metal Workers' Tools and their Uses. By Percival Marshall, A.I.M.E. (Dawbarn & Ward.) 6d. net.

Picture and Frame Restoring. By Thomas Bolas, F.C.S., F.I.C. (Dawbarn & Ward.) 6d. net.

History of English Literature. By A. Hamilton Thompson, B.A. (Murray.) 7s. 6d.

Meteorological Observations, 1900. Vol. XVII. (Rousdon Observatory, Devon.)

Essay on the Protection of British Birds. By H. S. Davenport. (Melton Mowbray: J. W. Warner, "The Library.") 6d.

Agathos. By Samuel Wilberforce, D.D. (Ward, Lock.) 6d.

Remarkable Eclipses. By W. T. Lynn. (Sampson, Low.) 6d.

Smithsonian Institution. Publications of the Bureau of American Ethnology. 17, Parts I and II; 18, Part I. (Washington: Government Printing Office.)

Annals of the Astrophysical Observatory of the Smithsonian Institution. Vol. I. (Washington: Government Printing Office.)

Pair of Celestial Globes. (Philip & Son.) 3s.

Directory. Part II. For Use in Schools and Classes in connection with the Board of Education. (Eyre & Spottiswoode.) 3d.

Bee Culture, as Exemplified at the Paris Exhibition. By Sir James Blyth, Bart.

Photographic Apparatus, An Abridged Catalogue of, supplied by Sanders & Crowhurst, 71, Shaftesbury Avenue.

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

Photo-trapping Birds.—"Phototrapping" is a term invented by Mr. R. B. Lodge, the well-known bird photographer, to describe a method which he has lately devised to cause birds to photograph themselves. Mr. Lodge describes his method in the *Zoologist* (Aug., 1901, pp. 290-293). Briefly, it consists of hiding a camera focussed and all ready for exposure near a nest or other point on which a shy bird is likely to alight. A dry-cell battery is hidden with the camera, wires connect the battery and the shutter with a specially designed switch. When the bird treads upon the switch the plate is immediately exposed. In Mr. Lodge's first experiments with the machine a peewit sat upon the switch for two hours and exhausted the battery, but an automatic cut-off has now been added. This ingenious method should prove a great boon to animal photographers, and will be an immense aid in securing photographs of very shy animals and birds.

Breeding Habits of the Swift (*Zoologist*, August, 1901, pp. 286-289).—By counting the birds in a colony and examining the nests the Rev. F. C. R. Jourdain shows that one pair of swifts will sometimes produce three eggs. Although three eggs have often been found in one nest the third egg has generally being considered the product of a second hen. If Mr. Jourdain has managed to accurately count the birds in the colony—a somewhat difficult task—then his case seems conclusively proved.

Lesser White-Fronted Goose in Norfolk (*Zoologist*, August, 1901, p. 317).—Mr. F. Coburn records that an adult female of this bird, which is considered by many systematists to be merely a form of the white-fronted goose, was obtained in Norfolk on January 24th, 1900.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 10, St. Germans Place, Blackheath, Kent.*

NOTES.

Astronomical.—Photographs taken by MM. Flammarion and Antoniadi, on August 19th and 20th, showed that Nova Persei was surrounded by a nebulous aureola having a definite sharp outline.

Among recent publications relating to variable stars, a paper by Dr. A. W. Roberts, the well-known South African observer, is of special interest. It is concluded that the variable R R Puppis consists of two bodies, one being three times the diameter of the other, but the smaller being about twice as bright as the larger, and the distance between their boundaries about two-thirds the radius of the orbit. In the case of V Puppis, the variability is accounted for by supposing the system to consist of two bodies of nearly equal size, but differing slightly in brightness, revolving in contact with each other.

Bulletin No. 4 of the Lick Observatory, which has been kindly forwarded by Prof. Campbell, gives an account of recent results obtained with the Mills' spectrograph. To the 25 spectroscopic binaries previously discovered are now added six more, namely, π Cephei, ο 31 Cygni, ξ Piscium, τ Persei, ξ Ceti, and ε Hydræ. An account is also given of observations which are in progress for a spectroscopic determination of the period of the interesting telescopic binary δ Equulei, it being at present doubtful whether the period is 5·7 or 11·4 years. Continued observations of Polaris indicate that the period 3d. 23h. 14·3m. completely satisfies all the observations for the revolution of the bright star round the centre of mass of itself and its dark companion; they also show further changes which support the conclusion that this pair revolves round the centre of mass of itself and a third body in a much longer period. Deslandre's discovery that δ Orionis is a spectroscopic binary has been confirmed, but the observations which have been made of α Persei do not confirm Mr. Newall's conclusion that this is also a spectroscopic binary. Another note relates to the velocity of 1830 Groombridge, which was mentioned in this column last month. In Bulletin No. 3 there are details as to 94 new double stars, 33 of which were discovered by Mr. Aitken with the 36-inch refractor, and the remainder with the 12-inch.

Further reports on the progress of the work for the determination of the solar parallax by the recent observations of Eros are given in Circular No. 8 of the *Conférence Astrophotographique Internationale*. The problem is by no means the simple one suggested by our elementary text-books, and we gather that about two years must elapse before the final result can be made known. Much of the labour involved is in getting the exact positions of the comparison stars used in the measurement of the planet's position at different times. A. F.

Botanical.—In the current volume of the *Journal of the Linnean Society*, Mr. I. H. Burkill has a paper on the Flora of Vavau, one of the Tonga Islands, founded on a collection of plants sent to Kew by Mr. C. S. Crosby. This island, which has a remarkably rich vegetation, is twelve miles long, and six miles across at its broadest part. Its temperature ranges from 70° F. to 90° F., and the annual rainfall is about 150 inches, as much as 9½ inches falling in one day. Mr. Crosby's collection consists of 262 phanerogams and 27 vascular cryptogams; while Mr. Hemsley, in his "Flora of the Tonga Islands," published in the same journal in 1894, enumerates 303 phanerogams and 33 vascular cryptogams for the whole group. It is interesting to note that 92 of the Vavau plants also occur in the Sandwich Islands, which are about 3000 miles distant. A common weed in the Tonga Islands is the sensitive plant (*Mimosa pudica*), which, Mr. Crosby says, "painfully reveals imperfections in the soles of one's shoes, though a native walks over it unconcernedly." The paper includes seven new species, three of which belong to *Eugenia*.—S. A. S.

Entomological.—It is not generally known that some caterpillars are to be included among the insects that live in friendly association with ants, yet in tropical countries the larvæ of "Blue" butterflies are often found under the ants' protection. A similar association has lately been observed in Switzerland by Prof. H. Thomann, who describes (*Arch. Sci. Phys. et Nat.* (Genève), Vol. X., 1900, pp. 565–6) the habits of the ant *Formica cinerea* with regard to the caterpillar of *Lycæna argus*. The ants run about over the caterpillars' backs in numbers, constantly touching them with their mandibles. They protect the caterpillars from the attacks of Ichneumon and Tachinid flies, and harbour the chrysalids in the galleries of their nests, allowing the butterflies to emerge unmolested. In return for these favours, the caterpillars secrete from a thoracic gland a sweet thick liquid, of which the ants seem to be very fond.

American observers are still busy unravelling the mysteries of ant-life on their continent. In the *American Naturalist* for March (Vol. XXXV., 1901, pp. 157–174), Prof. Wheeler and Mr. Long describe the males of some of the driver-ants (Ecitons) of Mexico, with notes on the habits of the colonies. They ravage other ants' nests, and convey the larvæ to their own galleries to serve as food, also they prey upon small ground-beetles. The victims seem to be stored up for several days before being devoured, and when the colony moves to a new nest the contents of the larder are not left behind.

In the *American Naturalist* for May (*l. c.*, pp. 337–356), Mr. C. T. Brues describes two remarkable new genera of small flies (Phoridæ). One (Commoptera) was found in a nest of the ant *Selenopsis geminata*, in Texas, the other (Ecitomyia) in a nest of Eciton. They resemble other related flies found in similar situations in the reduction of the wings (at least in the females) to useless vestiges, and the swollen membranous hind-body, which contains a gland, probably the source of some secretion appreciated by the ants.

The recent appearance of the dreaded Colorado beetle (*Doryphora decemlineata*) in large numbers in a potato field near Tilbury, Essex, has again called attention to the possibility that this terribly destructive insect may become established in these countries. Twenty-four years ago the rapid eastward migration of the beetle through the United States to the Atlantic seaboard, and the occurrence of stray specimens on a steamer at Liverpool, caused such alarm that a special Act of Parliament was passed to enforce its exclusion from our islands. On the present occasion drastic measures were taken by the Board of Agriculture, the whole infected crop being dug up and destroyed. It is to be hoped, therefore, that we may hear no more of such unwelcome invaders.—G. H. C.

Zoological.—The recent visit of Dr. C. W. Andrews, of the British Museum, to Egypt has resulted in discoveries of the highest importance in regard to mammalian palæontology. In company with Mr. H. J. L. Beadnell, of the Egyptian Geological Survey, Dr. Andrews visited the Fayum district, where a large number of mammalian and reptilian remains, many belonging to entirely unknown types, and in an excellent state of preservation were collected. A preliminary description of the mammalian remains has been published by Dr. Andrews in the September issue of the *Geological Magazine*. By far the most interesting of these belong to certain primitive types of Proboscidea—a group whose origin and relationships have hitherto been a puzzle to naturalists. As many of our readers are aware, this group has hitherto been known only by the elephants, mastodons, and *Dinotherium*. From (probably) lower oligocene strata Dr. Andrews now makes known a small mastodon-like animal (*Palæomastodon*), differing from the true mastodons by its simpler last lower molar, and also by having five pairs of cheek-teeth in use at the same time. More remarkable still is a creature from Eocene beds, termed *Moeritherium*, which has still simpler cheek-teeth, of which six pairs are simultaneously in use, and a nearly full series of incisors and canines. Very noticeable is the fact that the second pair of incisors in each jaw is much larger than the others, thus foreshadowing the upper and lower tusks of certain mastodons, of which the upper tusks of the elephants are the sole survivors. *Moeritherium* is, in fact, a generalized ungulate, bearing evident marks of being the ancestor of the elephants. A much larger beast (*Bradytherium*) reminds us in some respects of *Dinotherium*, and in others of the so-called Dinocerata of the American Eocene. If, as seems probable, Dr. Andrews has solved the problem of the origin and birth-place of the Proboscidea, he has earned the gratitude of all students of mammalian history. We await with interest a notice of the associated reptilian remains.

An addition to the important series of memoirs on the natives of southern India published from time to time in the *Bulletin* of the Madras Government Museum has recently been made by Mr. Fawcett, who treats of the Nayars of Malabar. The Nayars, the Nareæ of Pliny, are the swordsmen of the western coast of India, and are the best living examples of "matriarchy," or, to speak more accurately, of inheritance through the female sex.

In a memoir on Ruminants published in the *Handlingar* of the Swedish Academy of Science, Dr. Einar Lonnberg, of Stockholm, has some interesting observations on the structure of the horns and horn-cores of the oxen, sheep, goats, and antelopes, and how these vary in the different groups. The simplest type is that of the little African duikerboks, in which the horn forms a simple spike with a solid core. The more complicated spiral and ridged horns appear to have been modified to resist strain and torsion; but among these there is great variation, the cores of some, like the saiga antelope, being solid throughout, while those of others are spongy. From the somewhat similar form of their horns the author hazards the suggestion that the African buffaloes are more nearly related to the gnus than to their Asiatic representatives, but such a startling innovation is scarcely likely to be accepted without much stronger evidence.

It may be news to many that Spitzbergen possesses a race of reindeer peculiar to itself. Hitherto we have known very little about it; but in the *Memorie* of the Turin Academy of Science, Dr. L. Camerano publishes a full account of this animal.

Those of our readers interested in fossil corals should consult a memoir on the Palæozoic corals of Canada, by Mr. L. M. L. Lambe, recently published by the Geological Survey of Canada.

The Okapi, which has been so successfully mounted by Rowland Ward, Limited, is now publicly exhibited in the Natural History Museum, and attracts a large amount of attention on the part of visitors. Some of the groups of large mammals in the Museum are now being mounted in imitation of their natural surroundings. Among these are the zebras and the wild sheep of Central Africa; both cases have elicited much admiration from the public.

The latest issue of the *Transactions* of the Zoological Society contains the results of Mr. J. S. Budgett's investigations into the breeding habits of the African lung-fish, the bichir (*Polypterus*), and other fishes, collected by him in the Gambia. The results are too technical to be noticed in detail here, but general interest attaches to the account of the nest of the bichir, and likewise to the figures of the larval stages of this and some of the other fish, in which the plumed or thread-like external gills are beautifully shown.

THE MECHANISM OF A SUNSET.

By Arthur H. Bell.

Most people if they were asked to state the colour of the sun would say that it was orange, and they would as confidently assert that the colour of the atmosphere was blue. Recent researches and investigations, however, point to the conclusion that the real colour of the sun is blue, while that of the atmosphere surrounding the earth is orange. Commonly the earth's atmosphere appears so transparent and translucent that it is hard to realise the fact that it has as much effect on the light and heat coming from the sun as if it were a roof of thick glass. But the atmosphere is very far from being as colourless as it seems to be, and the best way of discovering its true tint is, not to gaze immediately overhead, but to look away towards the horizon. By so doing the atmosphere will be seen, as it were, in bulk; for overhead there is only a small accumulation of it compared with the many miles of thickness through which the vision travels when the eye looks towards the horizon.

The atmosphere surrounding the earth then may be likened to a screen of an orange colour, and it will readily be understood that any light passing through this screen will experience some remarkable modifications. Now, as already stated, it appears highly probable that supposing anyone could see the sun from a position outside the earth's atmosphere the light coming from this central luminary would be seen to be not white but blue. This blue is, of course, not a pure monochromatic blue, and the expression really means that it sums up the dominant note in the colour scheme. What, therefore, the atmosphere may be considered to do is to stop out, or absorb, all the colours at the blue end of the spectrum, the residue filtering through to the earth as white light. When the rays of light first left the sun, the blue rays were the strongest; but very soon after they entered the earth's atmosphere their progress was impeded, and of all the rays journeying from the sun they quickly became the weakest. On the other hand, the red rays which at first were inconspicuous, had the facility of penetrating the earth's atmosphere, and were the most in evidence at the end of their long journey.

The first step, accordingly, to be taken when investigating a sunset is to realise that the white light from the sun which is commonly supposed to be composed of the seven primary colours should rather be thought of as a residue of the original radiations. A further important point is to bear in mind that all radiations of light are of different wave lengths. This fact, indeed, is at the very foundation, so to speak, of all sunsets, and it is the prime agency by which their flaming, gorgeous tints and colours are produced. It is due to this fact, for instance, that in the neighbourhood of large towns, the sun nearly always appears to set as a red ball of fire. The rays of light at the red end of the spectrum are of a much longer wave length than any of their fellow rays, and so are the best qualified for penetrating the dense bank of haze which so commonly floats over all large towns and cities. In such localities, as the sun sinks to rest, the green rays are first absorbed by this bank of haze, and then the yellow, and lastly the orange and the red, the latter, more often than not, being the only ones to get through at all. A careful observation of a sunset will reveal the fact that the colours fade in the above mentioned order, and the reason they do so is that they are of different wave lengths.

In recent years the methods of observing the changes in the weather have been much improved, and since it is highly desirable that the observations should be capable of being compared with each other, the effort is made so to arrange that observations made at different places shall be conducted on a uniform plan. Now the colouring of a sunset gives such valuable information as regards the atmosphere in respect of the amount of moisture that may be floating in the air, that increased attention is being given every year to the work of observing and recording the quality of the sunset in various localities. The United States Weather Bureau, for instance, have in the principal streets of the large towns certain places where the latest weather reports and forecasts are displayed for the information of the public. In addition to this information there are also certain discs of various colours which are exposed in accordance with the colour of the latest sunset; and from this fact it will be gathered that the authorities attach a good deal of importance to information regarding the colour of the most recent sunset. It being clear, therefore, that sunset observations are of value, not only on the ground that they assist to a right understanding of the causes by which the sunsets are produced, but also because they are of use as aids to forecasting the weather, it becomes important that some systematic method should be devised for recording the observations, and it is satisfactory to know that a very simple way of registering sunsets has been adopted.

Supposing that anyone should be desirous of keeping a record of the colour of the sunsets in his neighbourhood, a record it may be said that will afford considerable pleasure, especially during the autumn days, there is a very easy way of going to work. All that needs to be done is to divide the sunsets into classes after the following manner. There are in the first place those sunsets which may be described as clear, this definition being taken to mean that there were no clouds in the sky, and few brilliant colours, the colour predominating being red. Further, the term yellow is employed to describe the quality of the sunset when this colour unmistakably overwhelms all others. Green is a colour rarely seen in sunsets, but when it appears at all prominently it serves to define a third class of sunsets. Fourthly, there are those sunsets which are best described as cloudy, and in this variety there is commonly a dense barrier or bastion of cloud that completely absorbs all colour and effectively darkens the western sky.

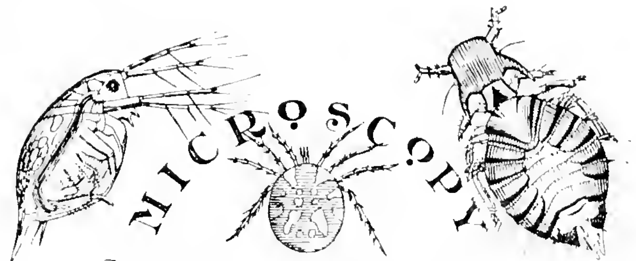
At many of the observatories scattered throughout the world, not only are sunsets thus relegated to certain definite classes, but, in order to give the record a scientific value, still further particulars concerning the sunset are added. Thus the position of the colours as regards their position in the sky, or as regards altitude and azimuth, as the terms are, are observed; while the time at which the colours were seen and any increase or decrease in the brilliance of the colouring would also be considered worthy of a place in the records. In all such systematic observations the time when the colours were at their brightest, and when they faded away, would be noted, and further, in order to make the record quite complete, the time of sunset or sunrise would also be registered.

Now the colour in the sky may, as it were, be painted on the clouds, or on the hazy air, or on the open sky itself. As regards the latter the colour that is most conspicuous is, of course, the blue, and in seeking for the origin of this tint it will be found that the search leads to an explanation of many of the other colours. On looking up into the sky on a cloudless, sunny day, when the swallows, perhaps, are flying so high that they appear but as tiny specks in the dome of blue, it seems almost impossible to think of the atmosphere as being otherwise than perfectly clear and translucent. It is, however, in reality charged with minute dusty particles which have always been found in myriads, whenever the atmosphere has been tested either over the open sea or at the top of high mountains. There is an ingenious instrument, indeed, by which the number of these atoms of dust in any given quantity of air may be counted, and by its aid samples of air in many different parts of the world and at different seasons of the year have been analysed and the atoms counted. The sources from which this atmospheric dust is obtained are large. From the land, and more especially from deserts, dust is continually rising, and the dust so raised is carried by the winds to all parts. Spicules of salt, too, leap from the sea in myriads, and go to increase the stores of dust. Other sources of atmospheric dust are found in the stream of meteors which are continually plunging into the earth's atmosphere, their combustion also resulting in atmospheric dust. Volcanoes again are important distributors of dust. A cigarette smoker casts some 4,000,000,000 dusty atoms into the air at every puff; while the shaking of door mats and other similar operations constantly serve to launch a never failing stream of dusty particles into the air. These particles of dust, it will be seen, are the agents principally responsible for tinting the atmosphere blue and for filtering out the gorgeous hues of a sunset.

In respect of these atoms of dust the atmosphere may be likened to some brobdingnagian vessel; for these atoms are always falling slowly downwards towards the earth like particles of chalk in a glass of water. As might therefore be expected, the lower strata of the atmosphere are most crowded and congested with these dusty loiterers, as is well illustrated when on a calm windless day these atoms settle downwards in such dense crowds and multitudes as to produce a dense black fog. But far above these lower levels the dusty atoms find their way, and since they are able to float so easily in these rarefied regions it is obvious that they must be of a lighter build and of more attenuated proportions than their relations which dwell where the air is dense. Even at these great heights there are ascensional currents of air which keep the tiny particles of dust floating. Although these particles are spoken of as dust, many of them are so minute that a microscope fails to render them visible, and the only way in which they reveal their presence is by their effects. Not only, therefore, do dusty particles pervade the atmosphere in all parts, but they vary in size from those that are coarse and readily discernible to others that are below microscopic sight.

Dusty atoms are further to be conceived as offering considerable resistance to the passage of the rays of light which emanate from the sun. Luminous bodies, as is well known, shed rays of light of varying wave length, as the term is; and as regards human vision only those rays whose wave length is between ·00036 and ·00075 millimetres can be seen. As these waves of light surge through the atmosphere, not only does their wave length affect their manner of passing through the earth's atmosphere, but the different sizes of the dusty atoms against which the rays of light strike introduce other modifications. Thus, many atoms of dust are of a smaller dimension than the wave-lengths of light that rush in among them. Hence it happens that the red and orange rays which are of a large wave length pass over these obstacles with comparative ease; but the blue rays which are of a shorter wave length are stopped, and the blue light is, as it were, turned out of its course and scattered. Lord Rayleigh has suggested that it is to this selective scattering of the finer rays that the blue of the sky is due. This action has been illustrated by observing what happens when a bottle of soapy water is held up between the eye and a brilliant light. Seen thus the light has a yellow or an orange colour, but when the liquid is looked at sideways it appears blue, the rays that have been scattered being thus made visible. When looking up into the sky a similar thing happens, for the blue tint is that which has been scattered from the sun-beams as they splashed, as it were, against the particles of dust suspended in the air.

In the lower strata of the atmosphere the coarser particles of dust not only scatter the waves of light, but they also reflect them, so that at these lower levels the blue tint is diluted by white light, and is accordingly not so intense as when seen, say, from the top of a high mountain. At this elevation only the finer varieties of dust are floating, and there is little reflection of the light, but much scattering, and hence it is here that the blue attains its greatest intensity. In that part of the sky nearest the sun the rays of light come in a direct line to the eye of the observer, and the scattering of the light does not appear so great as when one looks across the path of the beams, and it is due to this circumstance that the sky near the sun is not of so intense a blue as portions of the sky farther away. A similar kind of thing happens in respect of the clouds, where dust readily accumulates, and reflecting the light, produces their brilliant whiteness. At the edges of the clouds, moreover, the atoms of dust are busily engaged in refracting the beams of light, and to this cause is due that brilliant fringe of brightness which so often adorns many of the largest clouds. Not only, therefore, does the atmospheric dust filter out the blue light that tints the sky, but it also fabricates the pigments that colour the clouds, effects which can most readily be observed in contemplating the glories of the setting sun.



Conducted by M. I. Cross.

Drawing with a Camera Lucida.—Photo-micrography has largely displaced the use of the camera lucida for reproducing structure as seen through the microscope, but in numerous cases photo-micrography does not do justice nor reveal details in such a manner as to permit of a proper judgment being formed of the appearance of the subject; photo-micrography will only show one plane sharply at a time, and all sense of solidity, depth, etc., is lacking. When a drawing of an object is made the perspective can be reproduced and a far better and truer idea given of the object generally, subject of course to the delineation being accurate, than photography will permit.

Drawing with a camera lucida is an acquirement which calls for a considerable amount of practice, and is not successfully undertaken without a large amount of skill in the use of the pencil. This condition being fulfilled, very beautiful work can be and frequently is done.

Probably the most generally useful and popular of all the camera lucidas is that known as Beale's neutral tint, in which a piece of tinted glass is set at an angle of 45 degrees to the eyelens of the microscope, the upper surface reflecting the image to the eye.

I have a decided preference for this pattern, although it suffers from the disadvantage of necessitating the microscope being set horizontally, and the image is reversed at the top and bottom, while the sides remain constant. Still its simplicity recommends it, and very little acquaintance with it enables one to utilize all its capacity.

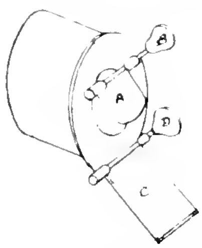
For many purposes a camera lucida that works with the microscope vertically, horizontally, or placed at any angle is desirable, and for such the Abbe Camera is generally considered the best.

The object is drawn as seen in the microscope, and when working, the mirror reflects the image of the pencil point and paper on which the pencil is tracing, into the apparent field of view.

I have recently been working with Ashe's Camera Lucida with the modifications described by Mr. Scourfield in the *Journal* of the Quekett Microscopical Club for 1900, and believe that for many purposes this will be found the most practical and convenient pattern of camera.

It combines the ease of working of the Beale's neutral tint without the transposition of the object and has not the disadvantage of bulk possessed by the Abbe Camera.

It can be used at any angle to which the body of the microscope may be inclined, from 45 degrees to the horizontal, quite comfortably, and by turning it round sideways on the eyepiece, it can be used at any angle from the vertical to 45 degrees.



Its general construction can be gathered from the accompanying drawing. The image from the eyepiece is received upon the mirror A, which consists of a silvered disc of microscope cover glass mounted on a brass plate, which can be revolved by the pin B, the image is then reflected to the neutral tint glass C, which revolves on the pin D, and the same effect is produced as in the Beale's pattern, excepting that there is no reversal of the sides.

I can strongly recommend the trial of this little device. Much of the failure in drawing with camera lucidas is due to the attempt to use eyepieces of too high power. It will be invariably found that an eyepiece magnifying six diameters or even less is the most satisfactory, and this equally applies to Ashe's Camera Lucida.

COLOUR PHOTO-MICROGRAPHY.—It has often been deplored that although very exquisite reproductions of delicate structure can be made by photo-micrography, no satisfactory means have been available for reproducing exquisite colour tints, which make the vision of numerous objects through the microscope so entrancing. Attempts have been made, and not without a marked degree of success, by means of the tricolour process of Ives and others, but it called for a high degree of technical skill, and a vast amount of patience, experiment, and time.

The Sanger Shepherd process of natural colour photography overcomes the majority of the difficulties which prevented workers from embarking on attempts in this direction. It is true that the results cannot be printed on paper, but must be viewed as transparencies: but they admit of ready exhibition through a projection lantern, and for direct examination can be held or supported towards a suitable white backing.

The great advantage of it is that no alteration has to be made to the ordinary camera. The recommended adaptation to the camera consists of a repeating back to carry three plates. Immediately in front of these plate-holders are fixed colour screens, which are guaranteed to be of exactly the correct absorption, and are adjusted by an improved form of Sir W. De W. Abney's colour sensitometer.

Three negatives of the same subject are taken, each with its appropriate colour filter. One print is taken from each of these negatives, and then stained by means of special solutions which are supplied. The three prints are then bound together in superposition to form a finished picture, and the result, if care has been exercised, is very fine.

Those who are in the habit of lecturing on microscopical subjects, or who have hesitated to do so because they cannot sufficiently reproduce the natural appearance of objects, should make a trial of this process, and a very little practice with it will cause them to be gratified with the results.

NOTES AND QUERIES.

C. J. R. Richards.—You will find the Platyscopic Lens a very good one for the purpose you name. It is an Aplanatic Magnifier, first introduced by J. Browning, of 63, Strand, under this name. There are many other good patterns, and in making a selection the principal points to consider are, the aplanatism, the diameter of the visual field, and the working distance. Some are now made in which these points have been specially studied. Messrs. Baker, Beck and Watson all describe them in their catalogues.

F. R. E.—It would not be possible for a novice to judge of the quality of objectives for himself. It requires experience and a critical eye to decide on the comparative values. You will be quite safe in trusting to any reputable firm for advice in the selection of the object glasses. You would certainly receive lenses of good performance from such.

W. R.—To view multiplied images in the facets of the cornea of a beetle's eye is quite simple. An easy method of doing it is to place on the mirror a small cross cut out of black or brown paper, about ¾″ long; illuminate in the usual way and focus the facets with ½″ objective. Then gently rack the objective upwards from the object, at the same time moving the paper cross on the mirror, very slightly, with a needle point, and the cross will appear in each of the facets. The needle itself will probably indicate the direction in which the cross should be moved in order to view it in the centre of the facets. The real secret lies not in focussing the facets themselves sharply, but in racking the body upwards until the cross comes into view, and focussing that sharply.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

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

THE GREAT SOUTHERN COMET (1901, I.).—The earth is now slowly approaching this object again, but its distance is too great to encourage the hope that it will be observed in anything but the largest instruments. In *Ast. Nach.*, 3734, H. Thiele, of Bamberg, gives an ephemeris, of which the following is an extract, for Berlin midnight:—

Date.	R.A. H.	M.	S.	Dec. °	′	Distance of Comet in Millions of Miles.
Oct. 3 ...	8	52	7	+ 10	47 ...	322
,, 7 ...	8	52	45	10	48 ...	321
,, 11 ...	8	53	7	10	50 ...	319

Early in October the comet will be close to the stars α^1 and α^2 Cancri, and with a very slight motion to the N.E.

ENCKE'S COMET.—This object has been visible in the morning hours since its discovery on August 5th, but is now too near the sun to be observed. Its rapid motion to the S.E. has practically carried it out of the reach of observers in the northern hemisphere.

AUGUST METEORS.—In the early part of August, 1901, moonlight and cloudy weather prevented observation. The night of the 10th was, however, very clear throughout at Bristol, and between 9½h. and 15h. the writer observed 102 meteors, of which 55 were Perseids, from a radiant point at 44° + 58°. A considerable number must, however, have eluded notice while the observer was engaged in registering the apparent paths of those seen. Had the sky been closely and uninterruptedly watched during the night, it is probable that a single observer might have counted about 180 meteors. The Perseids were not very numerous though they furnished more than half of the aggregate number of meteors seen.

The majority of the Perseids were small, but there was a fair proportion of large ones, three being as bright as Jupiter, but no fire-balls were seen. On August 11th, after a very stormy day, the sky cleared in the evening, and until nearly midnight the conditions were very favourable at Bristol for watching the shower. Between about 9h. 30m. and 12h. 30m. 72 meteors were seen, of which 49 were Perseids from a radiant at 45° + 58°. The Perseids were much more frequent than on the preceding night, and they were more brilliant, but the display was not a very rich one. The two brightest meteors recorded during the night were as follow:—August 11th, 11h. 2m.; magnitude twice as bright as Venus; path, 353½° + 7° to 343° − 14°. The meteor left a streak for nearly a minute between the stars δ and ψ Aquarii, and its appearance was very similar to that of a bright comet. August 11th, 11h. 56m.; magnitude equal to Venus; path, 120° + 74° to 160° + 65°. A very intense streak was left a few degrees N.W. of α Ursæ Majoris, but it died away in about 15 seconds.

Though the shower did not form a display of first-class importance it seems to have been richer than usual, and to have exhibited activity until August 21st and probably later. The visible character of an event of this kind is, however, always greatly enhanced under really good atmospheric conditions and it will generally be found that the Perseids are presented to the best effect in those particular years when clear skies and absence of moonlight favour their apparition. At most places the sky was clear or partly so on August 10th and 11th this year, and at some stations on August 12th also. The maximum appears to have occurred in the early morning of August 13th. At Bristol there were clouds on August 12th, 13th and 14th, but the next ten nights were clear, and offered a remarkable opportunity for tracing the display during its closing stages. Observations were obtained on every night between the 15th and 22nd inclusive by the writer, and 220 meteors were seen. A few Perseids were presented on every night of the period, though on August 17th and 19th the number was not sufficient to indicate a good radiant. On other dates the position was determined as follows:—

Date.	° °	
August 10	44 + 58	55 meteors.
11	45 + 58	19 ,,
15	51 + 58	6 ,,
16	53 + 58	5 ,,
18	55 + 59	8 ,,
20	57 + 58½	7 ,,
21	61 + 59	8 ,,

It is difficult to trace the Perseid centre after August 18th, as there are several showers of Camelopardids which are situated in the same region, and which supply meteors of the same visible aspect as the Perseids. A mass of very exact observations are required for several successive nights at this special period, when it might be possible to satisfactorily identify the meteors and assign their individual radiants. A large number of minor showers were seen in contemporary action with the Perseids this year, but for the most part they were extremely feeble. The writer thought the better defined of these were as below:—

° °	Meteors.	° °	Meteors.
24 + 43	5	310 + 61	11
63 + 30	6	312 + 13	5
106 + 52	5	335 + 1	15
263 + 62	7	335 + 73	13
239 + 47	7	345 ± 0	7
280 + 81	5	349 + 18	5
290 + 53	10	350 − 14	10

The latter seems to be a new shower. It supplied very slow meteors.

A comparison of the apparent paths registered by various observers has shown that about a dozen of the same meteors were noted at two or more stations. The real paths of these have been computed. Perhaps the most interesting object of this kind was seen on August 20th at 11h. 14m. at Bristol and Halifax. It was a small fireball brighter than Jupiter, and it fell from heights of 56 to 33 miles along a path of 41 miles, which it traversed at the rate of about 13 miles per second. The trail of the meteor is fortunately present on a photograph taken by Mr. C. J. Spencer at Halifax, which shows that the object, as it slowly penetrated the atmosphere, exhibited marked fluctuations in its light sufficient to give the trail a beaded aspect.

From various reports received from observers it appears that the shower was very generally and successfully witnessed this year, and it is clear that from certain of the descriptions already published some sensational things were seen. The various reports show how utterly impossible it is to reconcile the seeings of different persons, and that it is not only in the employment of telescopes, but in simple naked eye observation also, that we must attempt to smooth away large discordances on the assumption of weighty "personal equation." There is no doubt whatever that the Perseid shower of 1901 came and went without furnishing in itself any really startling features.

THE FACE OF THE SKY FOR OCTOBER.

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

The Sun.—On the 1st the sun rises at 6.3, and sets at 5.37; on the 31st he rises at 6.54, and sets at 4.34.

The Moon.—The moon will enter last quarter on the 4th at 8.52 P.M., will be new on the 12th at 1.11 P.M., will enter first quarter on the 20th at 5.58 P.M., and will be full on the 27th at 3.6 P.M. A partial eclipse occurs on the 27th, but as the last contact with the shadow is at 4.6 P.M., and the moon does not rise at Greenwich until 4.35, the phenomenon for this country will only amount to a penumbral eclipse in daylight. The eclipse ends at 5.26 P.M. The following are among the occultations visible at Greenwich 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. 1240	5.7	11.14 P.M.	120	160	1.53 A.M.	206	241	19 2
,, 4	71 Orionis	5.1	5.10 A.M.	58	61	6.0 A.M.	316	302	21 8
,, 7	60 Cancri	5.7	2.16 A.M.	59	78	3.1 A.M.	310	28	24 6
,, 17	ξ Ophiuchi	4.5	5.2 P.M.	139	135	[illegible]	203	183	5 4
,, 22	e^1 Capricorni	5.2	9.[illegible] P.M.	153	1[illegible]8	9.7 P.M.	156	141	10 8
,, 24	κ Aquarii	5.5	8.53 P.M.	61	56	10.6 P.M.	248	228	11 8
,, 25	λ Piscium	4.7	2.35 A.M.	73	35	[illegible] A.M.	217	268	12 14
,, 28	ο Arietis	5.8	5.32 A.M.	108	67	6.21 A.M.	235	196	15 17

Attention may be specially drawn to the interesting occultation of e^1 Capricorni on the evening of the 22nd.

The Planets.—Mercury is an evening star, at greatest eastern elongation of 25° on the 12th, but of too great a southerly declination for observations in our latitudes.

Venus is also an evening star, setting about an hour after the sun on the 1st, and about 1h. 50m. after him on the 31st. The planet will be low down in the south-west after sunset. At the middle of the month nearly three-quarters of the disc will be illuminated, and the apparent diameter will be 16″.2.

Mars is an evening star, but for practical purposes is not observable.

Jupiter remains an evening star, setting on the 1st at about 9.30 P.M., and on the 31st at about 7.50 P.M. The polar diameter diminishes from 35″.5 to 32″.7 during the month. The more interesting phenomena of the satellites, which may be observed at Greenwich under favourable atmospheric conditions, are as follows:—

		H. M.			H. M.
1st.—	I. Oc. D.	6 59	15th.	IV. Ec. D.	6 42
	II. Sh. E.	8 49		III. Oc. R.	7 38
2nd.—	I. Tr. E.	6 29	16th.—	I. Tr. I.	8 6
	I. Sh. E.	7 48	17th.—	I. Oc. D.	5 24
8th.—	III. Ec. D.	5 35		II. Ec. R.	8 35
	II. Tr. I.	5 55	18th.—	I. Sh. E.	6 9
	II. Sh. I.	8 32	23rd.	IV. Tr. E.	7 38
	III. Ec. R.	8 44	24th.—	II. Oc. D.	5 56
	II. Tr. E.	8 44		I. Oc. D.	7 19
	I. Oc. D.	8 54	25th.—	I. Sh. I.	5 46
9th.—	I. Tr. I.	6 7		I. Tr. E.	6 52
	I. Sh. I.	7 25		I. Sh. E.	8 4
	I. Tr. E.	8 25	26th.—	I. Sh. E.	5 52
10th.—	I. Ec. R.	6 57		III. Sh. E.	6 43

Saturn is a little east of Jupiter, the distance between the two planets diminishing to about 4° about the middle of the month. It will be interesting to watch the gradual approach of the two planets towards their conjunction of November 28th, when Jupiter will be a little less than half a degree south of Saturn. Saturn is in quadrature with the sun at midnight on the 3rd. On the 12th the apparent outer major and minor axes of the ring are 38″.04 and 16″.45 respectively, while the polar diameter of the ball is 15″.2.

Uranus is too near the sun for observation.

Neptune may be observed before midnight throughout the month, rising on the 1st about 9.20 P.M., and on the 31st about 7.20 P.M. The planet is in the western part of Gemini, stationary on the 5th, after which it describes a short westerly path, about 2m. 10s. preceding and 16′ 30″ south of η 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 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 11th at 11.1 P.M., and on the 14th at 7.50 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.

(C. D. Locock.)

No. 1.

1. Q to Q2, and mates next move.

No. 2.

Key-move.—1. Kt to QB5.

If 1.	. . Q to R8,	2. R to Q3ch.
1.	R × R,	2. Q to Q2ch.
1.	R to K5,	2. R × R.
1.	R elsewhere,	2. R to K5ch.
1.	K × Kt,	2. R × R mate.
1.	P × Kt,	2. Q × R mate.
1.	P to Kt4, etc.,	2. Q to Q4ch.

The try by Kt to KKt5 is answered only by 1. . . Kt to K5.]

Correct Solutions of both problems received from J. Baddeley, H. Le Jeune, G. Groom, S. G. Luckock, W. H. S. M., F. Dennis, C. C. Massey, Eugene Henry, G. W., G. W. Middleton, W. Nash, H. Boyes, C. Johnston, A. C. Challenger, Vivien H. Macmeikan, W. Jay, J. E. Broadbent (the above score 5 points), W. de P. Crousaz (4).

Of No. 1 only from W. Clugston, A. E. Whitehouse.

Of No. 2 only from F. J. Lea, G. A. Forde (Capt.), Alpha, Major Nangle.

W. Clugston.—Should be glad to receive another of your compositions.

W. Nash. Solutions amended as requested.

Major Nangle.—Q to Ksq is answered by P × Ktdis. ch.

Alpha. Your key to No. 1, "Q to Qsq," had to be interpreted as Q to Ksq, seeing that you give as a variation "1. . . P × Kt, 2. Q to Rsq (or B3)."

G. A. Forde and *W. de P. Crousaz.*—If 1. Q to R3, P × Ktdis. ch.

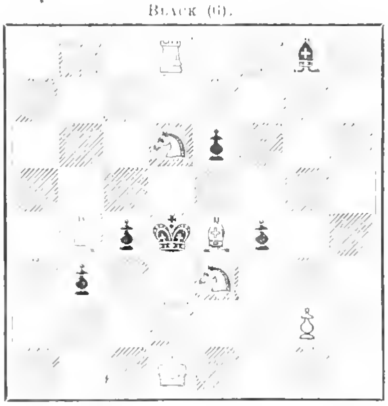
F. J. Lea.—If 1. B to Kt3, P to R7. The problem is of the "waiting move" class in the sense that mates are all ready prepared. But as there is no waiting move available, one of the prepared mates has to be given up for another, which constitutes the main variation.

PROBLEMS.

No. 1.

By N. M. Gibbins (Brighton).

Black (6).



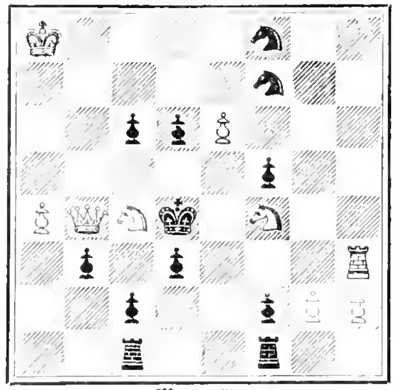
White (7).

White mates in two moves.

No. 2.

By B. G. Laws.

Black (12).



White (9).

White mates in three moves.

The relative positions of the twelve leaders in the Solution Tourney are unaltered this month, with the exception that W. de P. Crousaz, having lost one point, is now caught up by W. Nash and J. E. Broadbent. Messrs. Challenger, Jay, and Johnston have now scored fifty points each—the highest possible score. I regret to find that Mr. J. T. Blakemore, who was equal with them for the first six months, has apparently retired from the competition.

CHESS INTELLIGENCE.

The *Manchester Weekly Times* announces a problem tourney for two-move and three-move direct mates. Three prizes will be given in each section, and entries close on November 1st.

Mr. H. N. Pillsbury won the first prize in the annual tournament of the New York State Chess Association. Messrs. Delmar and Napier tied for second and third prizes, Mr. Howell being fourth, and Mr. Marshall fifth. It is stated that Mr. Pillsbury intends shortly to give up chess as a profession, but before doing so he contemplates a tour in Europe next year and, if possible, a match with Mr. Lasker.

Mr. E. O. Jones, who has probably played in more matches than any first-class player in England, has recently defeated Mr. J. Mortimer by 7 games to 4, with 1 game drawn, in spite of the fact that Mr. Mortimer won the first 3 games. At Carlsbad those old opponents Herren Albin and Marco are playing a series of ten match games.

The touring team of the Hastings and St. Leonards Club succeeded in winning all their seven matches in the west of England and Ireland, the total score in games being 87 to 51. In 1903 they hope to go still further afield if a tour among the German chess clubs can be arranged.

KNOWLEDGE

AN

ILLUSTRATED MAGAZINE

OF

SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

Vol. xxiv.] *LONDON, NOVEMBER, 1901.* [No. 193.

CONTENTS.

THE SINKING OF LARGE STONES THROUGH THE ACTION OF WORMS.

By Charles Davison, sc.d., f.g.s.

Twenty years have passed since Mr. Darwin published his last work.* If in his "Descent of Man," as one reviewer remarked, he had put down the mighty from their seat, in his "Vegetable Mould" he exalted them that are of low degree, and few of his many observations are more interesting than those which relate to the habits and rude intelligence of earthworms. Equally valuable and no less surprising were his measurements of the amount of soil brought to the surface by worms and of the rate at which layers of stones were covered by their castings. In different places, the castings were collected together from measured areas and were found to yield a layer of mould which, if spread over the same areas, would in ten years vary from about one to one-and-a-half inches in thickness. The depth of mould which accumulated over small stones strewn on the surface of fields was found, after intervals of seven to nearly thirty years, to range from 1·9 to 2·2 inches in ten years.

"When a stone of large size and of irregular shape," says Mr. Darwin, "is left on the surface of the ground, it rests, of course, on the more protuberant parts; but worms soon fill up with their castings all the hollow spaces on the lower side, for, as Hensen remarks, they like the shelter of stones. As soon as the hollows are filled up, the worms eject the earth which they have swallowed beyond the circumference of the stones; and thus the surface of the ground is raised all round the stone. As the burrows excavated directly beneath the stone after a time collapse, the stone sinks a little. . . . If, however, a boulder is of such huge dimensions that the earth beneath is kept dry, such earth will not be inhabited by worms, and the boulder will not sink into the ground."

Mr. Darwin gives several examples of this gradual sinking of large stones. It will be sufficient for our present purpose to quote one. A block of quartzose sandstone, 64 inches long, 17 inches broad, and from 9 to 10 inches in thickness, had been left on a bare surface of broken bricks and mortar. Thirty-five years later, when it was examined by Mr. Darwin, the ground surrounding the stone was covered with turf and mould, which for a distance of about nine inches round the stone gradually sloped up to it, and close to it the surface was about four inches above the surrounding ground. The lower surface of the stone was uneven, and the projections were still found resting on the brick rubbish, but the intervening spaces were filled up by worm-castings, so that, when the stone was removed, an exact cast of its lower side was left. The whole stone had sunk about 1½ inches in the 35 years, that is, at the rate of ·43 inch in ten years.

This estimate, however, must be less than the true amount, for some time would be lost in filling up the vacant space below the stone; and, in order to determine the rate more accurately, an experiment was commenced in the autumn of 1877 by Mr. Darwin's youngest son and continued during an interval of nearly twenty years. The results of this work were communicated to the Royal Society last May in a short paper, of which the present is an abstract.†

The place selected for the purpose was a nearly level field near Mr. Darwin's house at Down, which had probably been pasture for more than fifty years, and under a large Spanish chestnut tree.‡ A circular stone about 18 inches in diameter and 2¼ inches thick, and weighing about 41 lbs., was laid upon the ground. A hole was made through its centre and was lined with a brass cylinder, containing on the top three horizontal projecting pieces leaded into the upper surface of the stone. In each of these pieces a radial V-shaped groove was cut.

* "The Formation of Vegetable Mould, etc." (Murray, 1881.)

† Horace Darwin: "On the small vertical movements of a stone laid on the surface of the ground." *Roy. Soc. Proc.*, Vol. LXVIII., 1901, pp. 253-261. A preliminary account of the experiment was given by Messrs. G. H. and H. Darwin in their report on the lunar disturbance of gravity. *Brit. Assoc. Rep.* 1881, pp. 122, 123.

‡ This situation was afterwards seen to be unfavourable. Movements of the stone might be caused by the growth of the roots, and worm-castings are sometimes absent underneath trees.

To obtain a fixed point, from which the displacements of the stone were to be measured, two rods, one of copper and the other of iron, and each [illegible] of an inch in diameter, were driven side by side into the ground to a depth of about $8\frac{1}{2}$ feet, and the ends were cut off so that they stood at first about 3 inches above the ground, or not quite an inch above the upper surface of the stone, which was placed with the rods projecting through the central hole.

The measurements were made with the instrument shown in Fig. 1. A is a brass ring containing three

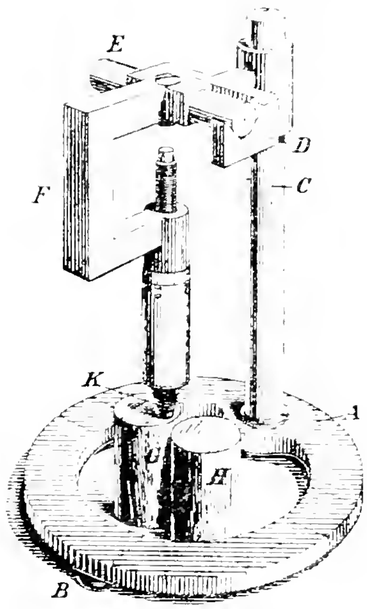


FIG. 1.—Instrument for Measuring the Movement of a Stone.
From the P[illegible] R[illegible] S[illegible]

rounded feet, B, which, at the time of reading, were placed in the V-shaped grooves mentioned above. C is a vertical brass rod, to which an arm D, with V-shaped bearings is soldered. An ordinary micrometer screw gauge, F, at the upper end of which trunnions E, were fixed, is placed with the trunnions resting in the V-shaped bearings, D. At the beginning of each measurement, the lower end, K, of the micrometer screw is vertically above the top of one of the rods, G, H. The screw is then turned until the end, K, just touches the rod, and the reading is taken. By moving the trunnions along the V-shaped bearings, D, the screw is made to touch the top of the other rod, and the reading repeated. The object of the double measurements with rods of different metals was to eliminate the small error arising from the expansion of the rods; but, in this respect, the experiment was unsuccessful, and the measurements given below are only those obtained from the copper rod uncorrected for expansion.

Movements of the stone [illegible] produced by other agencies than the burrowing of earthworms. Some, but an unknown, displacement [illegible] have been caused by the growth of the roots of [illegible] chestnut-tree, under which the stone lay. But the [illegible] occurred, must have been far less than that due to frost and changes in the dampness of the ground. The stone, indeed, was found to be in a state of continual vertical oscillation. When the soil was damp from recent rain, one or two cans of water poured on the ground near the stone made it rise [illegible]th of an inch in about seven hours. During a severe frost in the beginning of 1879 the stone rose [illegible]ths of an inch; and, during the thaw which followed a slight frost a little later in the same year, it fell nearly [illegible]th of an inch in less than five hours, even though the ground below was still hard.

The oscillations of the stone due to the varying dampness of the ground from Feb. 19 to Oct. 9, 1880, are represented by the continuous line in Fig. 2, the scale

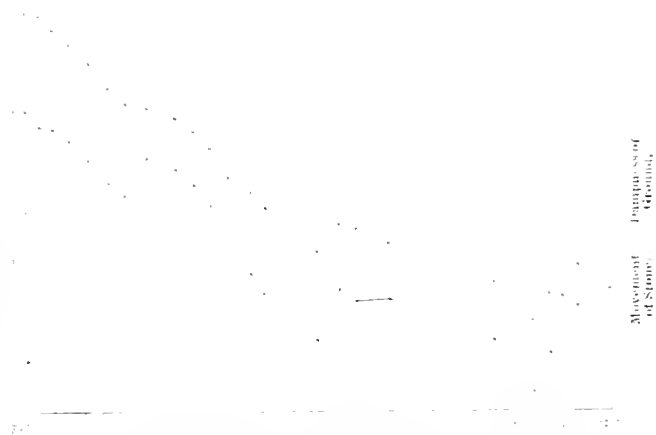


FIG. 2.—Diagram showing the Oscillations of the Stone.

being magnified so that each of the divisions on the left-hand side of the diagram represents [illegible]ths of an inch. The dotted line in the same figure indicates roughly the dampness of the soil, the ordinates being proportional to the amount of rainfall diminished by that which ran off or evaporated.§ With two exceptions, the cause of which is unknown, it will be seen that the curves follow one another very closely, especially during the latter part of the time. Between Sept. 7 and 19, there was heavy rain, and in the interval the stone rose [illegible]ths of an inch. At the beginning of 1881, there was a severe frost, and, owing to this and the previous wet season, the stone stood [illegible]th of an inch higher on Jan. 23 than on Sept. 7 of the previous year.

Until the end of 1886, the position of the stone was usually measured each winter and summer, and during the next ten years in the summer only. The curve obtained from the summer measurements is more irregular than from those made in winter, probably on account of the greater variation in the dampness of the soil in summer. During the last nine years in which the experiment was made (1887-1896), the total descent, given by summer measurements, was less than [illegible]th of an inch. It is difficult to account completely for this very slow rate, but, during part of the time, the rainfall was certainly above the average. In the earlier half of the interval, however, the rate of descent was much greater; though this may have been partly due to the decaying of the grass, for the stone was at first placed directly on the turf. Taking the winter readings, Mr. Horace Darwin found that the stone sank [illegible]ths of an inch in the eight years from 1878 to 1886, or at the rate of [illegible]ths of an inch in ten years. This, as we might expect, is much less than the rate at which worms cover up small pebbles, but it is about twice as great as that at which the large stone examined by his father sank into the ground.

§ The rainfall was measured at Leaves Green, a place about one mile from Down and nearly on the same level. In estimating the deduction for evaporation the soil was supposed to dry at a uniform rate.

THE WHITE NILE FROM KHARTOUM TO KAWA.

AN ORNITHOLOGIST'S EXPERIENCES IN THE SOUDAN.

By Harry F. Witherby, F.Z.S., M.B.O.U.

V.—BIRDS.

One of the finest sights in bird-life is that of a falcon taking its prey. Lanner falcons* were fairly common on the White Nile, and several times they swooped down upon sandgrouse which we had winged, and attempted to carry them off. Usually, however, a shout would make the falcon drop such easily won prey. One day when we were riding, a bird rushed over our heads at a terrific pace flying towards the river, which was not more than a hundred yards away. Before we could determine the species of the bird there was another rush of wings over our heads, and looking up we saw two lanner falcons flying side by side. They did not appear to be going very fast, but their pace must have been great, since in the short distance between us and the river, they made up the thirty yards or so between them and the bird they were chasing. Just as they caught it up, one of them shot forward slightly and made a downward swoop like a flash. It then sailed on along the river's edge, while the other immediately turned and flew leisurely back the way it had come. There had been no struggle and no uneven movements on the part of the falcon and nothing to indicate that the prey was taken. We could only imagine that the pursuers were disappointed and that they did not care to continue the chase across the river which the quarry seemed to have reached, but as it had unaccountably disappeared from our sight we could not be sure. The falcon which had made the swoop and was flying along the river's edge settled upon the ground some 200 or 300 yards away from us, and then to our intense surprise we saw that it had indeed captured its prey in that rapid swoop, and that it was now standing upon it and tearing it. We shouted and fired a shot and the falcon rose, but bore off its prize and would not release it, so that we could only conjecture from the brief sight that we had of it as it was rushing over our heads, that it was a pigeon or a sandgrouse.

Sandgrouse shooting at many points along the banks of the White Nile affords such sport that millionaires would give untold gold for were it to be had in England or Scotland. For an hour or more between 7 and 9 in the morning one can stand behind a bush or sand-hill with a continuous stream of birds passing like rockets backwards and forwards over one's head. Flock after flock comes down from the dry dusty desert to the cool waters of the river. The birds generally stay at the river for but a few moments. Alighting on the edge of the water or often with their feet submerged, they take a sip or two, and then flying up and whirling round, shoot back to their desert home. In some places, however, where broad grassy flats bordered the river, a large number of sandgrouse were to be found all day, and they seemed to live and feed there in preference to the arid inland country. There were two species of these sandgrouse. The majority were of a species† with a sandy-coloured back and a rich dark breast, a bird which is found in astonishing numbers over the greater part of the northern half of Africa. The other species‡ was decidedly rare and only seen singly or in pairs and never in flocks. It was a larger bird of a less uniform colouring, and with orange on the throat and cheeks.

Although these birds afforded good sport and were, besides, a very welcome addition to the wiry fowls and an occasional, and always aged, sheep or goat which we obtained from the natives, the shooting of them was by no means a pleasure. The great dry heat of the Soudanese summer injured almost everything we possessed, and the effect it had upon the white powder with which our cartridges were loaded produced most trying results. I was told by an expert at home that the extreme dryness of the atmosphere withdraws the moisture from the powder and so causes a too rapid explosion. The fulminate in the cap of the cartridge is affected in the same way, and, as a consequence, all the powder is probably ignited at once, a great deal of gas is generated, and a considerable explosion occurs. The result is extremely uncomfortable and annoying. After shooting 10 or 12 cartridges one becomes quite deaf, and the recoil of the gun makes a considerable bruise. Moreover, a strong heavy gun after a time was so damaged as to become dangerous to use. We found that the explosion was much more violent after the cartridges had been carried in the sun for some hours, and also after several shots had been fired in quick succession. Metal and glass exposed to the sun were always burning hot, and after a few shots had been fired quickly a gun was too hot to hold with the bare hand. I am advised on good authority that this violent explosion of white powder in a hot dry climate could be prevented by using a small cap and a small charge of powder. A charge of 35 grains of Schulze to one oz. of shot in a twelve-bore cartridge instead of the usual charge of 38 grains of powder would remedy the defect without deteriorating the killing power. But care must be exercised in the loading, and the extra space in the cartridge case must not be filled with hard wads or used for a deep "turn-over," which would tend to keep the powder back and increase the recoil.

Besides the sandgrouse, pigeons§ provided us with many a meal—indeed, too many. So numerous were these pigeons and so thickly did they cluster in the trees that, to save time and ammunition, we often shot from twelve to sixteen with a single cartridge. The pigeons were great drinkers, but unlike the sandgrouse, their favourite hour for imbibing was just before sunset. Sandgrouse also came down to the river just then, but only irregularly and in small numbers. Apparently only the very thirsty individuals drank in the evening as well as the morning. After their drink the pigeons flew to a considerable height in the air and then, arriving above their intended roosting place they suddenly closed their wings and hurled themselves down like stones. Just before the tree-tops were reached they checked their headlong plunge with outstretched wings, and circling round once or twice, alighted noisily in the acacias. In fact this downward plunge to the roosting trees was performed by these African pigeons in much the same way as it is by our wood pigeons at home.

One evening, from the same spot, I fired some twenty shots at pigeons as they were plunging down, and I noticed in a tree thirty yards away from me a little bittern‖ which sat motionless stretched upwards as stiff as a ramrod during the whole cannonade. We saw many little bitterns in the trees in the Soudan and they generally adopted this stiff and attenuated attitude,

* *Falco tanypterus*, Schl.

† *Pteroclurus exustus* (Temm.).

‡ *Pteroclurus senegallus* (Linn.).

§ *Turtur ambiguus* Boc., *Turtur roseogriseus* (Sundev.).

‖ *Ardetta minuta* (Linn.).

which is undoubtedly assumed for purposes of concealment. I have seen the bird in the same attitude amongst green reeds in Spain, but there, as in the acacias in the Soudan, the bird benefited nothing by this strange posture. The little bittern is a cream-coloured bird with a velvety black back and head, and I think it could never be taken for a stick or reed except perhaps in broken light. With the brown-coloured common bittern, which adopts the same pose, the case would be different. One might suppose, however, that the little bittern itself considered the attitude a complete protection by adopting it on the approach of danger, and by remaining motionless through such a terrifying ordeal as the sound of the twenty shots I have mentioned. Had the bird frequented the thicker trees, its stick-like attitude might have saved it from detection, but in the open trees in which we generally found it the trick was a ludicrous failure.

There were other birds in this country which either by their protective colouring or by their attitudes were rendered inconspicuous and often invisible. Those which relied upon their colour for concealment were, as would be expected, birds of the open country, and their colouring was, of course, like the sand. Of those I have mentioned—various species of larks were difficult to see even when they were flying, the fantail warbler was exactly the colour of sand or dead grass; the sandgrouse was impossible to distinguish at a short distance in the desert, as were the cream-coloured coursers on the sand by the river. The birds living amongst the trees depended upon the thickness of the branches and twigs for concealment, and although there were few trees with leaves, it was extraordinary how perfect a protection they were afforded. Even the most brightly coloured birds were hidden in a thick mimosa bush or acacia tree, and most of the shy birds seemed to recognise this fact, and rather than fly away would retire into the thickest part of a tree. Mouse birds or colies,* for instance, flew into a tree and disappeared as if by magic. They have a sweet piping note, and often on hearing this sound I used to creep under the tree from which it came and watch these long-tailed parakeet-like birds creeping and climbing as mice in and out amongst the thickly-growing twigs and branches in the centre of the tree. On catching sight of me looking up at them they would give a hurried, rather gasping, pipe, and climb with wonderful dexterity and swiftness towards the outside of the tree furthest away from danger. When all had arrived on the edge they would fly away, softly piping.

Birds of the night are perhaps the cleverest at hiding themselves. Once when strolling round a mid-day camp to escape the groaning of the camels as they were being loaded, I saw what appeared to be a broken piece of bough in a very thick tree. I was struck by its rather bird-like shape, but should have passed it had I not the habit of looking with my binoculars at puzzling sights. The binoculars made the stump look still more bird-like, and after walking all round the tree I at last made out two horns, which I knew must come from the head of an owl. I ran to the camp for a gun and fetched my companions, who assured me the thing was only a stump. I fired at it and down fell two owls, while a third flew away. So that the "stump" was in fact three birds huddled up together. They were beautiful little horned owls of a rare species.**

The only other owls we found were a large handsome eagle owl,†† and a white or barn owl.‡‡ The latter was rather more spotted on the breast than our familiar English bird, and for this reason Brehm, who collected birds in the Khartoum district many years ago, gave the barn owl of these parts the sub-specific name of *maculata*. It is remarkable that although the barn owls are spread over most of the world they preserve so constant a type that, unlike the generality of birds in similar case, they cannot be separated into different species, although their slight variations enable the diligent systematist to divide them into races or subspecies. The fact that the barn owl seldom migrates, and is a more or less sedentary bird, makes its want of variation all the more remarkable. The only bird of this species that we found inhabited the rocky hill, Gebel Auli, which I have already mentioned as the haunt of bats and hedgehogs. The owl seemed to have no mate and lived in a small cavern in the rock. This had perhaps been used as a nesting place, and it was littered with castings of the rejected fur and bones of the bird's prey.

It was after climbing about this hill and searching its crevices from top to bottom that Mahomet, my stately gunbearer, said he felt very ill and must have a doctor. We considered that he was malingering, but when he told us that he was always accustomed to be bled once a month and had not now had any blood drawn for two whole months, we bowed to his decision and waited eagerly for the doctor. The real doctor of the village of some twenty huts at Gebel Auli was away

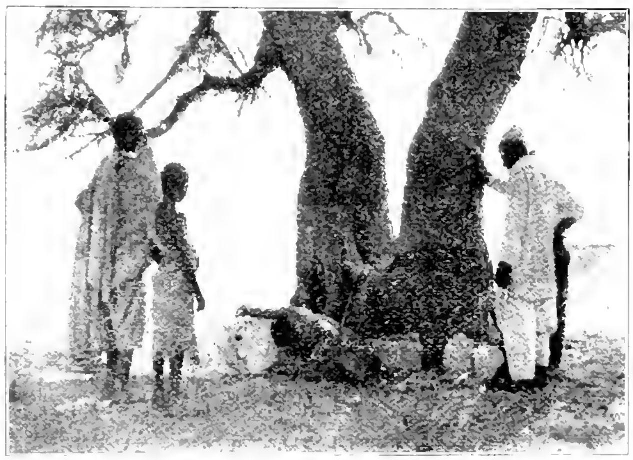


FIG. 1.—Bleeding Mahomet. The doctor adjusting the "cup."

on a journey, but his *locum tenens*, who was a decidedly inferior practitioner we were told, put in an appearance. After a long harangue Mahomet decided to be operated on by him. The doctor came unprovided with a lancet, but he soon borrowed a razor from Salim, one of the camel men. His only other instrument was a piece of a cow's horn with the narrow end closed by a bit of tin. Mahomet resignedly lay down in the shade, and the operation, the various stages of which we somewhat callously photographed, commenced. The patient's head was shaved and then the cow's horn was placed on the side of the neck. The doctor applied his lips to this primitive "cup" and sucked vigorously until a vacuum was formed, when he closed the opening with the piece of tin. In a few minutes the horn was taken off and revealed a large bump raised on the neck. A

* *Colius macrurus* (Linn.). ** *Scops leucotis* (Temm.).

†† *Bubo lacteus* (Temm.). ‡‡ *Strix flammea* (Linn.).

few cuts were made with the borrowed razor and then the horn was put on again and the blood drawn out by the vacuum. By repeating this process seven times on

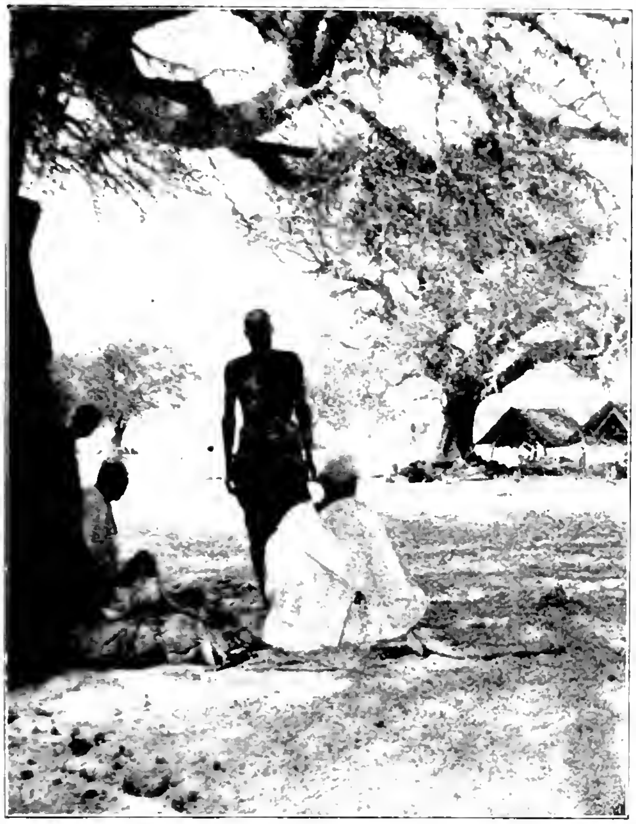


FIG. 2.—The "cup" fixed on the neck.

each side of the neck the doctor drew some 5 ozs. of blood from Mahomet. The moderate fee of one piastre (2½d.) was charged but we were told with some pride that the proper doctor would have charged two piastres. We had always considered Mahomet wanting in blood, but on the morning after the operation he said that he was now perfectly well and we cheerfully believed in the efficacy of the leech.

We rather thought that so primitive a doctor should have a primitive fee, such as an old bottle or tin, or even a bit of cloth, for his own was of the scantiest. But the natives as far as we travelled would take nothing but money. We had provided ourselves with knives, razors and the like for barter, but these would never be accepted as payment although they were demanded, but not given, as baksheesh. Hassan's explanation of the use to which the money was put, ran as follows: "Dey do put it in hole in ground and ebery six months or year dee faber ob dem do go to next big billage and buy in bazaar all tings for ladies and him and—eberyting."

THE INSECTS OF THE SEA.—VI.

By GEO. H. CARPENTER, B.SC.(LOND.), *Assistant in the Museum of Science and Art, Dublin.*

FOUR-WINGED FLIES.

THE various orders of insects that may be roughly designated "four-winged flies" have very few marine representatives. Every student of pond-life knows the hairy-winged Caddis flies (Trichoptera) whose grubs—the Caddis-worms—live in fresh water and build up for themselves little houses of stones, sticks, leaves and even snail-shells. Some caddis-worms inhabit brackish-water, and it is of special interest to the New Zealand species *Philanisus plebeius*,* which dwells in the sea between tide-marks. It was found by Capt. Hutton in Lyttleton Harbour in a straight tubular case made of fragments of coralline seaweeds and tiny stones. The great order of the moths and butterflies (Lepidoptera) is represented at sea only by stray specimens flitting along the shore or by migrating swarms of strong-flying species crossing channels or oceans. But the Hymenoptera (comprising the saw-flies, gall-flies, ants, wasps and bees) seem to have some truly marine members. Prof. Moniez discovered† near Aigues-Mortes on the French Mediterranean coast, crowds of minute black parasitic flies (belonging to the family Proctotrupidae), sheltering under stones between tide-marks. These had well-developed wings, which they may perhaps use as propellers when swimming through the water.

BUGS.

OUR survey of the Insects of the Sea must conclude with the bugs—the order Hemiptera (or Rhynchota) of zoologists. These are far from being the most highly organised of insects, and their marine representatives are comparatively few. Yet among them are found not only haunters of the tidal margin and the rock-pools, but also daring adventurers trusting themselves boldly to the waters of the ocean, over whose surface they walk, often hundreds of miles from land. This order of insects shows, therefore, the most perfect adaptation to marine life.

The characteristic structural feature of Bugs is to be found in their jaws, which are formed for piercing and sucking. The mandibles and first pair of maxillae are transformed into piercing stylets, which work to and fro in a grooved beak made up by the fusion of the maxillae of the second pair. This beak usually rests beneath the insect's breast with the point directed backwards. Unlike the higher insects—such as Beetles, Moths, Flies and Bees—the Bugs undergo no marked transformations. The young, except for the absence of wings, are hatched in a form much like that of their parents, and attain the adult condition by slow degrees, the wing-rudiments—visible outside the body—gradually increasing in size after each moult. In the marine Bugs, however, wings are never developed at all.

Like other orders of insects, the Bugs show a gradual transition in some groups from a terrestrial to a marine habit of life. The dull, oval, convex insects forming the genus Salda, for example, have some species frequenting dry heaths, others haunting the edges of ponds and streams, and yet others dwelling close to tidal water or on salt-marshes; these latter are well able to endure submersion, and at high tide they sometimes crawl slowly about under water.

But most of the truly marine Bugs belong to markedly distinct and isolated genera. The only example of the Order found on the sea-coasts of our islands, though related to the Saldidae, is now placed in a family all by itself—a family comprising but a single species.

* R. McLachlan, "On a Marine Caddis-fly from New Zealand," *Journ. Linn. Soc. (Zool.)*, Vol. XVI. 1883, pp. 417-422.

† R. Moniez, "Sur un Hyménoptère Halophile," *Rev. Biol. N. France*, Vol. VI., 1894, pp. 434-441.

Aepophilus Bonnairei‡, as this insect was called some twenty years ago by its describer, M. Signoret, is a flattened, elongate oval bug about ⅛ inch long, with the hind-wings apparently absent and the fore-wings reduced to very small vestiges (Fig. 1). The name Aepophilus was bestowed upon the insect because of its discovery in company with beetles of the genus Aepus, described in a previous article of this series. It has never been found except between tide-marks, and almost always seems to shelter under stones, though it has been noticed also beneath a stranded star-fish. On the coast of Sark, M. Koehler found specimens beneath large stones in a cave into which the tide only permits entrance four times a year. Mr. Keys, who has observed the insects on the south-west coast of England, found them to occur in greatest numbers beneath large boulders in a channel far out beyond a reef of rocks—a situation covered by the sea for twenty hours out of the twenty-four. Here "in a space that could have been covered by a crown piece, there was a group of the undeveloped forms with a single mature specimen in their midst, just as one often finds a family of earwigs, or sees a hen surrounded by her chickens." The life of these strange insects beneath great boulders at the sea-bottom is full of mystery. Apparently they can neither survive immersion in sea-water, nor walk on the surface; "they hide in companies in little holes in the stone, packed together as closely as possible, or rest on the algaic growth thereon." Probably these humble seaweeds furnish them with food, though it has been suggested that they eat decaying animal matter. Aepophilus is a very scarce insect, and seems confined to the western European and Britannic coasts. It has been observed in Spain; on the Ile de Ré, off the west coast of France; Jersey and Sark in the Channel Islands; Dorset, Devon and Cornwall in south-western England; and Waterford in southern Ireland. Such a distribution, together with

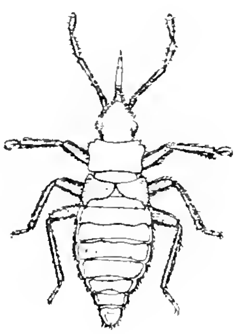


FIG. 1

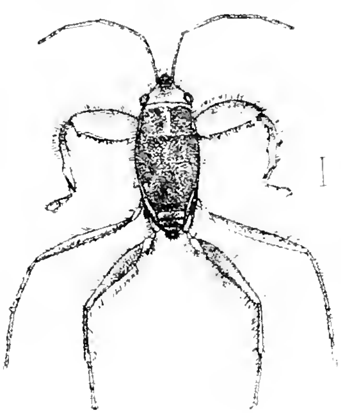


FIG. 2.

FIG. 1.—*Aepophilus Bonnairei* (male), with beak extended, Jersey. Magnified 9 times.

FIG. 2.—*Hermatobates Haddoni* (male), Torres Straits. Magnified 6 times.

its isolated systematic position and retiring habits, shows that it must be an ancient type of bug, driven to extremities in order to maintain any standing at all in the teeming insect-world of to-day.

‡ V. Signoret. "Le Genre Aepophilus." *Tijdschr. Ent.*, Vol. XXIII., 1880, pp. 1-3, pl. 1.—R. Koehler. "La Faune littorale des Iles Anglo-Normandes." *Ann. Sci. Nat. (Zool.)*, Vol. XX., 1885, pp. 27-9.—J. H. Keys. "Aepophilus Bonnairei." *Ent. Mo. Mag.*, Vol. XXIV., 1888, p. 171; (2), Vol. I., 1890, p. 247; (2) Vol. VI., 1895, pp. 135-7.—E. Bergroth. "Notes on the genus Aepophilus." *Ent. Mo. Mag.* (2) Vol. X., 1899, pp. 282-3.

Far away on tropical coral-reefs lives another peculiar genus of marine bug. Hermatobates, as this insect is called, is as small as Aepophilus, and far more remarkable in structure. The three segments of the thorax are fused together, wings are entirely wanting, and the abdomen has undergone such extreme reduction that the slender middle and hind legs look to be inserted at the far tail-end of the body. The fore-legs are very broad, strong and spiny, evidently adapted for clinging, and perhaps for seizing prey (Fig. 2). Of the life of these curious insects hardly anything is known. The typical species, discovered on a reef off the island of Mabuiag in Torres Straits by Prof. Haddon in 1889, and named after him by the present writer,§ was subsequently met with on Guichen Reef, near Troughton Island in the Arafura Sea by Mr. J. J. Walker. "They occurred," he writes, "under large dead bivalve shells (Tridacna), and with them I found a good-sized spider which must have been submerged on this completely isolated reef twice every day to a depth of ten or more feet." It is curious that Prof. Haddon's specimen also occurred in company with a spider—*Desis Martensii* by name—well-known from various maritime stations in the eastern tropics. It is likely that further research will show some beneficial association between this large spider—who retires at high water into holes in the coral-rock protected by a sheet of web—and her tiny companion.

Only during the present year has a second species of Hermatobates been discovered, MM. H. Coutière and J. Martin having described one from the coast of Somaliland, in East Africa. These little bugs have evidently therefore a wide distribution in the tropics. The same naturalists also record the occurrence on Honda Bay in the Philippines of an allied insect, which they refer to a distinct genus Hermatobatodes. Only females of the latter have been found, while of Hermatobates only males are yet known. These, like many other Bugs of the "sterner sex," seem able to produce musical sounds to charm their mates, for a comb-like row of spines on the face of the flattened fore-shin can hardly be regarded otherwise than as a stridulating organ.

The East African species, *H. djiboutensis*, was not found crawling on the coral rock, but skimming over the surface of a pool, and the Philippine insect occurred on the waters of the bay. These marine Bugs, therefore, sometimes at least, adopt the habit of the well-known pond-skaters, Gerridæ, in which family they must probably be included, though they certainly form a very aberrant sub-family thereof. Among the Gerridæ adaptation for walking on the surface-film of water reaches its highest point.

One of the best known European fresh-water members of this family is the dark brown *Velia currens*, which may often be seen darting about over the surface of running streams. In most tropical countries species of the allied Rhagovelia are to be found. These insects have a wonderful and beautiful organ for assisting their walk over the surface-film, in a system of branching ciliated hairs set in the deep cleft of the terminal segment of the feet of the middle pair of legs (Figs. 4, 5). This set of hairs can be retracted and hidden within the cleft of the foot, or spread out like the spokes of a wheel so as to form a disc-like area of support. Two

§ G. H. Carpenter. "Rhynchota from Murray Island and Mabuiag." *Sci. Proc. R. Dublin Soc.*, Vol. VII., 1892, pp. 137-146, pls. XII., XIII.—H. Coutière and J. Martin. "Sur une nouvelle sous famille d'Hémiptères marins, les Hermatobatinæ." *Comptes Rendus Acad. Sci.* Vol. CXXXII., 1901, pp. 1066-8.

or three marine species ... to Rhagovelia have been discovered on the ... tropical American seas, in all cases close to land, and in consequence of the remarkable development of this ... wheel-foot ... have

FIG. 4. FIG. 3. FIG. 5.

FIG. 3.—*Trochopus plumatus* (female), Jamaica. Magnified 9 times.
FIG. 4.—Terminal Segment of second foot. Magnified 75 times.
FIG. 5.—Arrangement of ciliated hairs. Magnified 156 times.

received the name of Trochopus. These bugs (Fig. 3) are covered with a dense velvety pile which prevents them from being wetted. Occasionally at least they dive beneath the surface of the water, when they carry an air-bubble down with them. Another marine wingless relation of Velia was discovered on Cartier Island in the Timor Sea by Mr. J. J. Walker, and made by Dr. Bergroth• the type of a new genus—Halovelia.

Of the same general build as Velia, but with narrower body and much longer and more slender legs, the true "pond-skaters"—various species of the genus Gerris—may be seen disporting themselves, both in winter and summer, on stagnant and running fresh-waters in our islands. The only insects that venture on a life on the "high seas" are near relations of these familiar aquatic Bugs. Of course the oceanic habit has been gained by degrees, and the gradual process of modification can be traced among the related genera.

The aquatic Bugs of the genus Metrocoris ... differ from those of Gerris, among other characters, in the much shortened hind-body beyond which the wings, when at rest, extend for a considerable distance. Some of the species inhabit fresh-waters in the eastern tropics, while others, in which the wings are absent, are found on the surface of salt-water in estuaries and harbours. These wingless bugs were classed with the oceanic Halobates to be described below, until Dr. Buchanan White referred them to a distinct genus Halobatodes. Recently Dr. Meinert has shown that in some cases at least, these estuarine insects must be regarded as ... undeveloped forms** of their winged fresh-water relations.

We ... therefore ... in the very act of adopting a marine life ... in consequence the power of flight. In ... Gerridae *Velia currens* is a notable example ... and wingless adult forms occur. Apparently ... whose fresh-water home may occasionally dry up ... some winged individuals to seek a fresh breeding place and perpetuate the species. But those who have ventured on the bosom of a great estuary have what is practically a boundless surface of water over which to glide. Wings, therefore, are not only unnecessary, but as we have seen in the case of the marine flies (p. 198, above) rather a source of danger, which can be advantageously given up.

The estuarine Metrocoris, then, with its mixture of winged and wingless species, leads us on to the truly oceanic Halobates, in which wings are altogether unknown. As in marine insects generally, the size of these bugs is small—a body length of ¼ inch is unusual. They are smooth oval insects, rounded and dark coloured above, flattened and pale below, the body covered with a dense velvety pile that keeps them dry. The fore-legs are rather stout and adapted for seizing floating objects, while the great development and fusion of the two hinder thoracic segments thrusts the long slender middle and hind-legs back to the tail-end of the body, the abdomen being greatly shortened. An especially beautiful adaptation for their surface-walking is seen in the delicate fringe of long hairs borne on the shin and first foot-segment of the legs of the middle pair (Fig. 6).

The earliest discovered species of Halobates were described by the Russian naturalist Eschscholtz in

FIG. 6. FIG. 7.

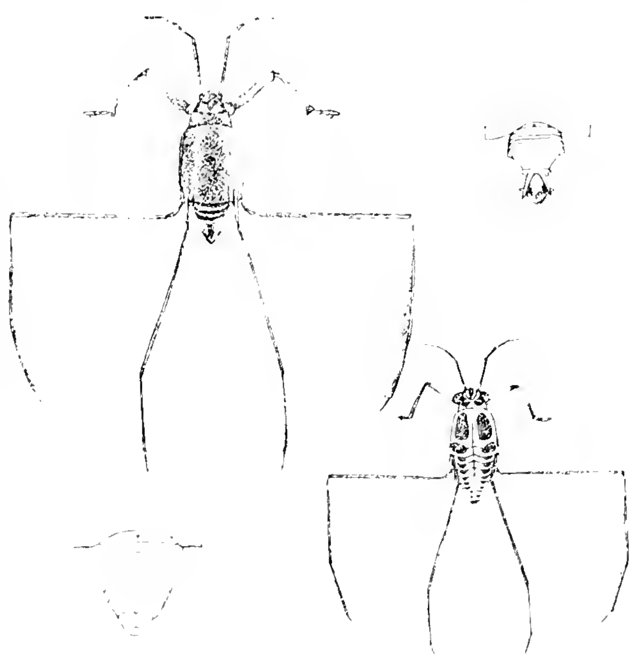


FIG. 8. FIG. 9.

FIG. 6.—*Halobates regalis* (male), Torres Straits. Magnified 4 times.

FIG. 7.—Underside of abdomen (male). } Magnified 6 times.
FIG. 8.—Underside of abdomen (female). }
FIG. 9.—Nymph. Magnified 4 times.

1822. All the references to these insects made by writers during the succeeding sixty years may be found in Buchanan White's admirable monograph of the genus

G. H. Carpenter. "A new Marine Hydrometrid." *Ent. Mo. Mag.* (2) Vol. IX., 1898, pp. 78-81, 109-111, pl. III. G. C. Champion. "Biologia Centrali-Americana. Hemiptera-Heteroptera." Vol. II., 1898, pp. 140-1, pl. 9. G. W. Kirkaldy. "Aquatic Rhynchota." *Bollet. dei Musei di Torino*, Vol. XIV., 1899, No. 350, pp. 1-6.

• E. Bergroth. "On two Halophilous Hemiptera." *Ent. Mo. Mag.* (2) Vol. IV., 1893, pp. 277-9.

** F. Meinert. "Slaegten Metrocoris og dens Form ... Halobatodes." *Entom. Meddels.*, Vol. I., 1888, p. 11.

contributed to the "Challenger" Reports.†† Since his work some studies on the internal anatomy of the insects have been made by Witlaczil and Nassonoff, while our naval entomologist Mr. J. J. Walker has contributed some valuable observations on their habits and life history.

The most striking features of internal structure are the presence in the thorax of organs usually found in the abdomen (on account of the great reduction of the latter region) and the immense development of the muscles for working the long middle and hind legs. A remarkable gland ("belly-gland" of Nassonoff) opens beneath the foremost abdominal segment in both sexes. The tail end of the body is highly modified in the male (Figs. 7-8).

Fifteen species are known, most of which are restricted to one or other of the great oceans, but *Halobates sericeus*, Eschs. occurs both in the Atlantic and Pacific, while *H. micans*, Eschs. (=*Wüllerstorfi*, Frauenf.) ranges over the whole oceanic area of the tropics. Apparently these insects cannot exist without a considerable amount of heat, as they are almost unknown on the temperate seas; stray examples of *H. micans* have occurred as far north as Spain and Carolina. They abound most near the shores, and have even been observed jumping about seaweed cast up on the Red Sea beach. But they have been noticed more than 1000 miles from any land. Their brick-red eggs are very large as compared with the size of the mother, who sometimes carries two or three about attached to the under surface of her body. Witlaczil records that the Italian surveying ship "Vettor Pisani" picked up in the Pacific Ocean, off Galapagos Island, a floating bird's feather covered with masses of eggs of Halobates, surrounded with a gelatinous envelope. It seems therefore that the eggs are laid on floating objects.

Floating objects, indeed, serve these tiny ocean-travellers with much-needed rest and food. They have been noticed clinging by their anchor-like fore-claws to masses of seaweed and they suck the juices of jelly-fish. Their fresh-water relations, the pond-skaters, are often described as predaceous, but they seem to prefer a dead or dying to a living victim. Probably, therefore Halobates are to be reckoned among the scavengers of the sea. Of their manner of life, Mr. Walker writes:—"In tropical latitudes, when a sailing ship is becalmed or a steamer is stopped in a perfectly calm sea, it is not long before little whitish creatures are seen rapidly skimming over the glassy surface with a sinuous motion, and soon half a dozen or more Halobates are in view at once, evidently attracted by the bulky hull of the ship, which they will approach frequently within arm's length. Their progress appears to be effected by a sort of skating action of the long ciliated legs. . . . . A heavy swell, provided the weather is quite calm, does not prevent their appearance, but with the ripple caused by the slightest breeze they vanish at once; though sometimes they were to be found in plenty on the narrow belt of smooth water to leeward of the ship, when not one was to be seen on the windward side." Mr. Walker kept specimens alive, confined in a vessel of sea-water. "On the approach of the finger or a pencil they dive readily, and swim with great facility beneath the surface, the air entangled in the pubescence giving them a beautiful appearance like that of a globule of mercury or polished silver. This supply of air must be essential to the existence of the insects, which I feel sure must pass a large part of their life beneath the surface of the sea, diving into undisturbed water in rough or even in moderate weather, and coming up again only when it is absolutely calm."

Considerable difference of opinion has prevailed among the students of these insects as to their exact relationship to their fresh-water allies. Buchanan White considered them a very archaic group, doubted if they ever possessed wings, and, laying stress on their likeness to the young nymphs of the pond-skaters, was inclined to regard them as ancestral to the Gerridæ. Witlaczil and Nassonoff on the other hand consider them highly modified and aberrant forms. There can be little doubt that this latter opinion is nearer the truth, as the loss of wings in marine insects can be traced under our very eyes, notably in the related genus Metrocoris, and the likeness of the pond-skater nymph is much more marked to the young (Fig. 9) than to the adult Halobates. Still, the pelagic life of Halobates shows that a long period must have elapsed since their immediate ancestors forsook the fresh-water for "that great and wide sea wherein are things creeping innumerable, both small and great beasts." Among all the living creatures of the sea few yield in interest and mystery to these frail insects.

It is likely that the animal life of our globe began in the waters of the sea. But the largest monsters of the deep, the great whales and their kindred, together with these "Insects of the Sea," are undoubtedly invaders from the land—driven out of the crowded continents to find a home, if not a resting-place, in that vast ocean which was the cradle of their far-off ancestors in the early ages of the earth's history.

†† F. Buchanan White. "Report on the Pelagic Hemiptera." 'Challenger' *Zoology*, Vol VII.—J. J. Walker. "On the genus Halobates and other Marine Hemiptera." *Ent Mo. Mag.* (2), Vol. IV., 1893, pp. 227-232.—E. Witlaczil. "Zur Kenntnis der Gattung Halobates." *Zool Anz.*, Vol. X., 1887, pp. 336-9.—N. Nassonoff. "Halobates flaviventris var Kudrini" (in Russian), Warsaw, 1894 (abst. in *Zool. Centralbl.* Vol. I. pp. 702-4). For further modern literature see G. H. Carpenter "Challenger Expedition." *Nat. Sci.*, Vol. VII., 1895, pp. 60-61.

CONSTELLATION STUDIES.

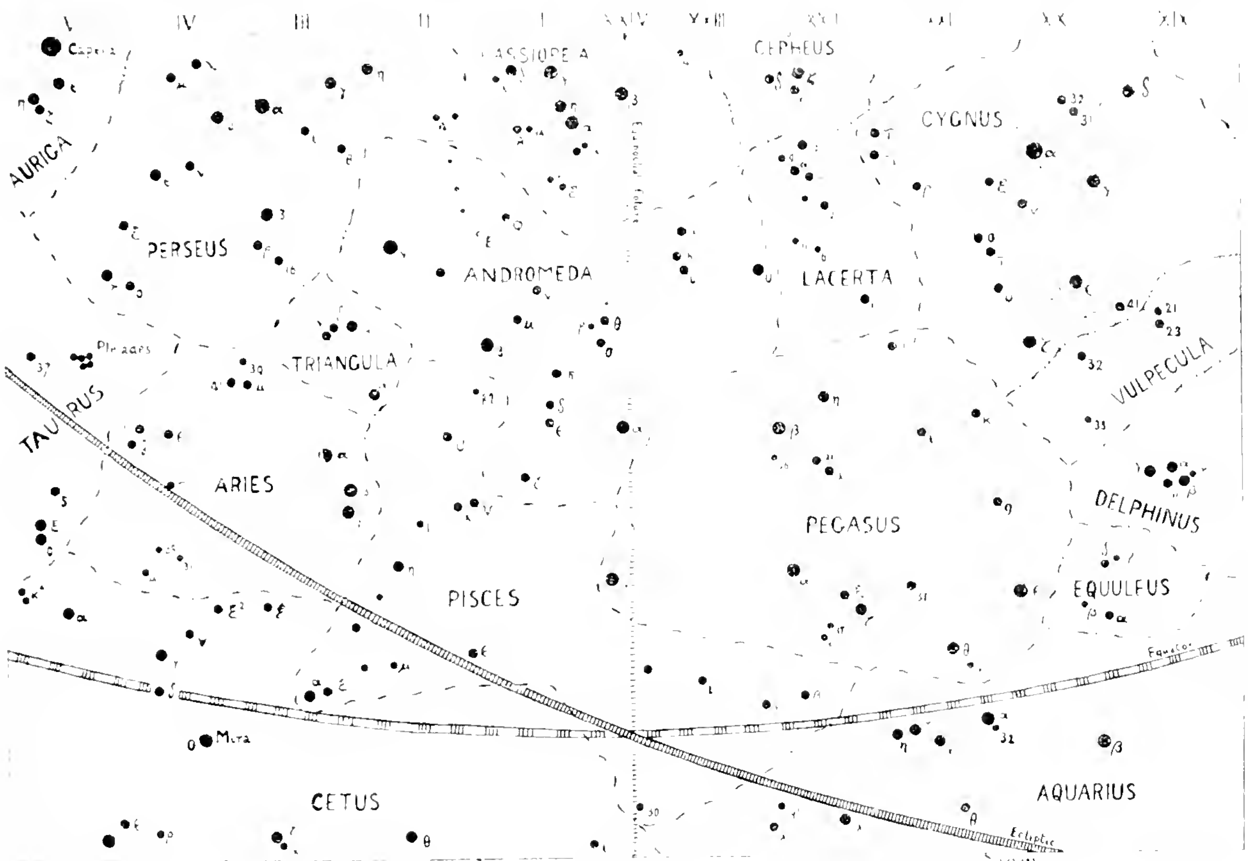
By E. WALTER MAUNDER, F.R.A.S.

X.—THE ROYAL FAMILY.

ABOVE the long group of watery constellations with which we have been occupied of late, and connected with them, may be seen a cluster of constellation figures which, unique amongst the stellar designs, set forth a distinct and well-recognized story. These are the five constellations which, together with Cetus, preserve to us the legend of Perseus and the maiden whom he delivered. The story, as it has come down to us from Greek sources, is one beloved of romancists in all ages and in all lands. A lovely maiden, innocent herself of any fault, is yet condemned, in order to expiate the offences of her parents, to be exposed to some terrible disaster. Her case seems beyond hope or help when at the very crisis of her fate, a young hero who has already abundantly proved his mettle in other fields, appears on the scene. Her beauty and her distress alike appeal to him; and to his victorious powers, her deliverance is a light task. The threatening monster is easily disposed of, and what promised to be a grim and terrible tragedy, ends with triumph and rejoicing to the sound of wedding bells.

It may be, as Brown assures us, that we have in the Andromeda legend but another version of the all-pervading solar myth. Perseus may be Bar-Sav, the son of hair, that is to say, the solar Herakles clad in his lion's skin, and Andromeda, his bride, the rosy red dawn; but if so, the dead myth has passed through minds who could fill it with a human interest, and so imbue it with the spirit of life. As in the story of Pygmalion, it may be that that which was cold and dead was the original; but surely for us, as for him, the living Galatea is not only more worthy, but is more real and true than the lifeless marble whose form she bore. So, we may still look upon Andromeda and Perseus as no mere abstractions of natural phenomena, but as the innocent persecuted maiden and her gallant deliverer; the old romance, ever new and ever true throughout the ages of the world's long history.

Two of the five constellations, Cassiopeia and Cepheus, were touched upon in the first of these papers. The chief stars of the group now under consideration are



Star Map No. 10.—The Region of the Royal Family.

easy to find when once we have found Cassiopeia. When Cassiopeia is in the zenith, as she is about 10 o'clock at this time of the year, then may be seen high up in the sky, but slightly to the west of the meridian, four stars marking out the corners of a figure which is generally known from its shape as the square of Pegasus. Taking the two upper stars of the square, which are now known as Beta Pegasi and Alpha Andromedae, and proceeding eastward, we find three bright stars at about the distance apart from each other that the stars of the square are, and which are respectively Beta and Gamma Andromedae and Alpha Persei. The latter is readily found. The Milky Way streams down from the zenith where Cassiopeia is seated, to the east point of the horizon; and along its axis, a chain of bright stars run down from Cassiopeia. The brightest of these is Mirfak [illegible] elbow, Alpha Persei, marking the elbow of the hero as the word denotes [illegible] three bright stars form the upper points of [illegible] W just below the smaller, more distinct W of Cassiopeia. The lower points of the W are marked by [illegible] Alpha Persei, better known as Algol, the [illegible] so called from its wonderful variation, and Beta Trianguli, the brightest star in the small but ancient constellation of the Triangle.

This little constellation, insignificant as it is in itself, is of great importance, from the evidence which it supplies that the ancient constellations were the result of deliberate design and forethought. Brown's remarks on this point are so just that I may be forgiven for quoting them. Referring to the type of explanation popular in a certain school, he says: "They would say that someone noticed these stars, saw they resembled a triangle, called them the Triangle, and everyone else followed suit; a pretended explanation which merely repeats the fact that such a constellation exists. It is clear, as Brown further points out, that there are hundreds of stars which might have been combined in triangles and which would have equally suggested such a figure. Not a few would have suggested it much more strongly; as, for example, the stars in the head of Taurus. The selection therefore of these by no means conspicuous stars to form the constellation of the Triangle is a strong indication that, not only the designs, but their positions were matters of definite purpose to the old constellation makers.

The principal characteristics of the three constellations, Andromeda, Pegasus, and Perseus, as they are [illegible] our star atlases are preserved for us in [illegible] of Aratus. Of the first he says:—

[illegible]

His description of the constellation of Pegasus is one of the fullest and most detailed of any. There is no [illegible], however, to quote the whole, but [illegible] attention to the circumstance that the star now known as Alpha Andromedae, the upper left hand star of the square, is common to the two constellations. Its name, Alpheratz, [illegible] the Horse, perpetuates the same tradition.

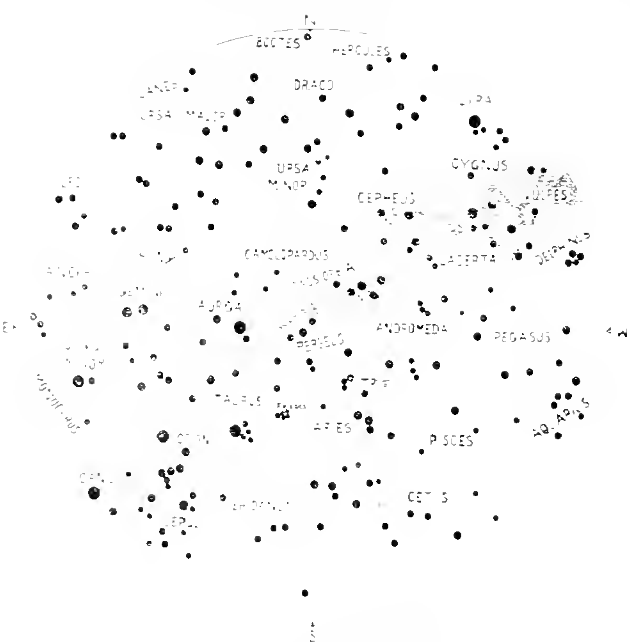
[illegible]

That is to say these three with the star common to the two [illegible] up the square.

Of Perseus, Aratus says, after referring to Andromeda:—

[illegible]

The "cloud of dust" alluded to is the Milky Way, on an arm of which Mirfak, the chief star of the constellation, stands. This "dust" round Mirfak supplies perhaps the finest field for an opera-glass in the entire sky, the whole region being full of winding streams of stars of the most attractive form. Moving upward from Alpha towards Cassiopeia, we pass through Gamma and Eta Persei. From Eta Persei half-way to Delta



[illegible]

Cassiopeia [illegible] great cluster of Perseus, one of the [illegible] have to present. [illegible] triangle formed by Gamma Persei, Gamma Andromedae and Algol. It is the comet-like [illegible] Messier. Crossing over to the constellation of Andromeda, Gamma Andromedae marks the neighbourhood of the shower of meteors associated with Biela's comet, and now encountering our earth about November 23. Passing on to Beta Andromedae, we find that the starting point of a line of three stars pointing upwards towards Cassiopeia. The next of these stars to Beta is Mu, the third Nu, close to which, towards the east, lies the great nebula of Andromeda, 32 Messier—after the great nebula in Orion the finest example of that order in our skies.

The entire region of Perseus repays examination with the opera-glass, and of Andromeda the regions nearest the Milky Way. Pegasus is much less interesting, but possesses a naked-eye double in Pi, the star in the horse's hoof.

Two small constellations in this region of the sky may receive a passing notice. Immediately below the Dolphin and close by the head of Pegasus, is the little group Equuleus, the "Forepart of a Horse." It is placed in the sky in such a manner as to suggest that Pegasus is not rushing through heaven alone, but is in close company with a yoke fellow, whose head, indeed, is just seen, but whose body is hidden from us by that of Pegasus. The constellation is not mentioned by Aratus but it is stated that Hipparchus formed it from stars formerly belonging to the Dolphin. It is described as we now have it in the catalogue of Ptolemy.

The other group is Lacerta, the Lizard, a few faint stars gathered together by Hevelius to form a constellation fitted in between Cepheus, Cygnus, Pegasus and Andromeda. Except that it marks the radiant point of the Lacertids, a meteor shower, active in August and September, there is nothing to distinguish the group. Apparently at one time the fore leg of Pegasus crossed this region, since Pi Cygni, which lies beyond it from Pegasus, bears the name Azelfafage, the "hoof of the horse."

NOVA PERSEI.

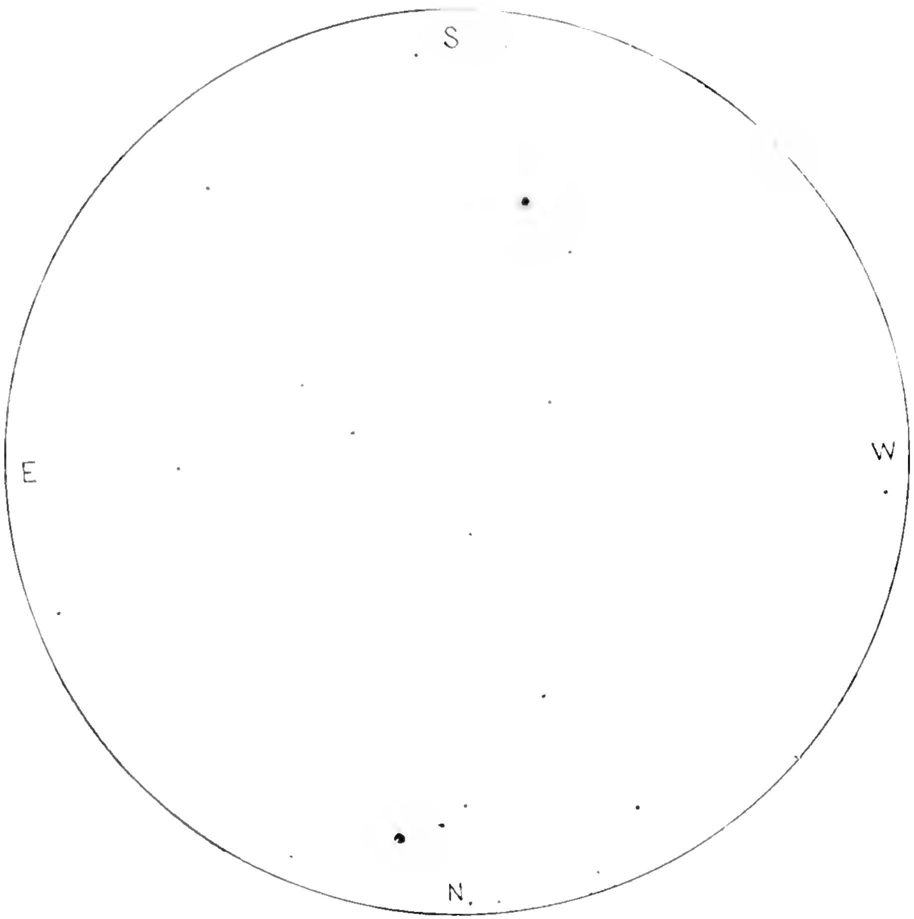
By E. M. ANTONIADI, F.R.A.S.

ON a photograph taken at Juvisy by the writer on August 19 last, with M. Flammarion's portrait lens of 6¼ in. aperture and 27½ in. focal length, the image of the *Nova* appeared quite different from that of the stars. The exposure was 30 minutes only, so that the image measured only about $\frac{1}{50}$ inch in diameter. Its peculiarity lay in the fact that whereas ordinary stars impress the plate as slightly "nebulous," radiating discs, the *Nova* showed a strong, sharply defined "penumbra," round a small, dark nucleus. The diameter of this "aureola" was 2″. On the whole, the appearance was not unlike that of a normal, quiescent, sunspot.

The following night, August 20-21, proved admirably transparent, and a plate was tried from 23h. 26m. to 3h. 6m. G. M. T., with an effective exposure of some 3 hours and 20 minutes. On this negative, the 2″ "aureola" is quite black. But the *Nova* is surrounded by another one of 6″. Enlarged views of these images will be found in the annexed figure, carefully drawn by the writer from the originals, while the Plate gives photographic enlargements of them.

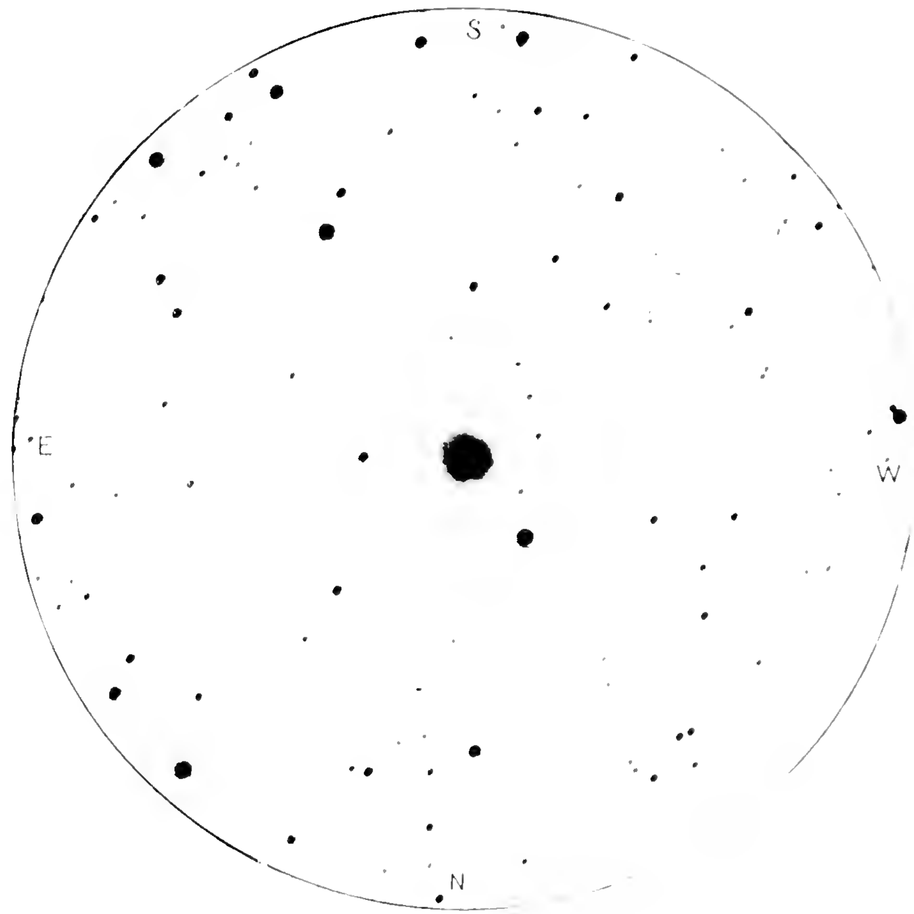
Notwithstanding the fact that a few weeks before these photographs were taken, the spectrum of the *Nova* had drifted into that of a nebula, it was obvious that the "nebulosity" round the image of the star could not be real. Its sharp boundaries, which repeated all the optical defects of the object glass, precluded the possibility of such an interpretation. This view was, therefore, communicated to Mr. Crommelin, of the Royal

PHOTOGRAPHIC IMAGES OF NOVA (3, 1901) PERSEI.



LESSER "AUREOLA."

1901 Aug. 19. Exposure 0h. 30m. Enlargement of 6·2 times the original



LARGER "AUREOLA."

1901 Aug. 20-21. Exposure 3h. 20m. [illegible]

Observatory, Greenwich, in the following terms (Aug. 21):—"A careful consideration of the various negatives led me to the conclusion that the sharp penumbra round the *Nova's* photographic image is not objective: that is, I do not consider it as a real nebulosity. Its

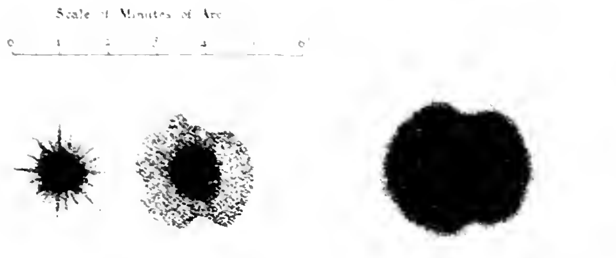


Image of an Ordinary Star with the [illegible] Lens. *Image of Nova Persei with [illegible] 1901, August [illegible].* *Image of Nova [illegible] exposure [illegible] August 20.*

radiated structure makes me rather think that the phenomenon might be due to a difference in the nature of the *Nova's* light, as compared to that of the other stars." The answer was (Aug. 25):—"Mr. Ellis noticed last March that its image was much less sharp than other stars. I believe his photographs were taken with a reflector, so that a difference in the quality of its light would not explain this, though it might in the case of photographs taken with a refractor, as I believe yours were." It will be seen that this reply of Mr. Crommelin's hits at once upon the right interpretation, as drawing attention to the possibility that the *Nova* might emit rays for which the object glass is not corrected—an idea which received an experimental corroboration, a few hours later, at the hands of Prof. Max Wolf, of Heidelberg, who, by stopping one-half of his glass, so as to give the exposed part a semicircular form, obtained a semicircular "aureola" on the plate. In a recent letter, Prof. Wolf attributes the lesser "aureola" to green rays, the larger one to violet. The subject is worth closer investigation and it would be interesting to have the opinions of our best authorities on it.

Letter.

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

AMONGST ANTARCTIC ICEBERGS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Having quite lately returned to England from New Zealand, *viâ* Cape Horn, I think an account of our voyage—as it proved a somewhat eventful one—may interest your readers. I was a passenger on board one of the New Zealand Shipping Company's newest and finest ships, and those who know that company will not need to be told we were in excellent hands with the commodore of their fleet as our commander. We left Wellington on Thursday afternoon, August 15th, and put on an extra Friday, which we called "Antipodes" (as we were crossing the Meridian which passes through the Islands of that name), and thus lived through the 16th day of the month a second time in order to make our dates tally on arrival in England. By Tuesday, 20th, therefore, we had made a six days' run from New Zealand [illegible] at noon [illegible] S., 141° W. [illegible] and the sky overcast. We [illegible] dinner that evening at about [illegible] the captain and the chief officer were both [illegible]. News at sea spreads like wildfire, and it was but a few minutes afterwards that everyone knew there was a very large iceberg on our port side. It [illegible] little to get up excitement at sea, and we [illegible] all taken by surprise, as it is the rarest occurrence to pass an iceberg, even in those latitudes, in the month of August or even in September, as it is then only just past midwinter. It had been *intensely* cold all day with a feeling in the air which no doubt accounts for the sailors' expression of "smelling ice." Very soon we had another iceberg to our starboard. A few minutes later and we had three about us, then seven, and by the time we turned in we had the uncomfortable, and somewhat uncanny knowledge that there were no less than twelve icebergs *in sight*, and this at night, so how many there may have been in reality, no one can tell.

There could be but one opinion as to what would happen had the ship run into an iceberg, as we were then at least 1600 knots from land and but few ships pass that way.

In the morning we awoke to find ourselves surrounded by seventeen icebergs, the number increasing throughout the day, until at one moment I myself counted thirty-two altogether, and there were floes of ice all about us.

On one occasion, during that first night, as we were slowly coasting round a monster of about three miles long, the captain suddenly discovered that it was joined *under the water* to a berg on our other side. A great block had probably fallen away. It was just towards dawn and the light was so extremely bad that it was just a mere chance that the rippling of water over the covered ice showed our danger. To have continued would have meant certain disaster. The starboard engine was at once reversed so that the ship might turn more quickly than she could have answered to the rudder, and we rounded our adversary on the southern side. We were amongst the icebergs altogether about sixty hours, for it was not before Friday at mid-day that we were finally clear of them. Not only were they quite unexpected, but neither the captain (in over fifty voyages round the world) nor any of the officers in all their experience had ever come across icebergs either in size or number to equal those which made ours a record voyage.

Some idea of the number passed in the space of two days and a half may be formed when I say that 707 really large bergs were actually *sighted*; and it was estimated that altogether we must have passed about 1200 of them. In size they were gigantic. Some were one, two, and three miles in length, and one was five miles long. In height they varied from 50 to 150 feet, and one had a peak considerably higher. (These measurements were taken by sextant.) When it is considered that only 1/7th of an iceberg's bulk is visible above water, some idea of their stupendous size may be gained from the above measurements. The captain could only suggest as a reason for their presence at such an unwonted time of year and in such numbers and magnitude that some great volcanic disturbance had taken place in the Antarctic regions probably caused by the active volcanoes Mount Erebus and Mount Terror in whose neighbourhood hot springs are known to exist. No ordinary circumstances could apparently have accounted for their size or number. As to their beauty there can be no question. They assume every sort of appearance from the grotesque to the magnificent, and from the weird to the wonderful. One will resemble a mountain with a village perched on its side; another will make one think of an enormous arm-chair, or couch, or perhaps a table; in another we shall see a majestic castle with frowning battlements, turrets and tower complete; or perhaps an animal of the elephantine order will pass before us; or, again, we are greeted by the cliffs of Dover! Some sail along laden with snow, glistening in the sunshine; others are iridescent with all the colours of the rainbow.

H. E. B.

SOME PECULIAR ANIMAL PRODUCTS.

By R. LYDEKKER.

OF animal wax other than spermaceti (the product of the sperm-whale and certain other allied species) the great producer is the familiar honey-bee, an insect which has been kept in a state of semi-domestication from time immemorial, and is now spread over the greater part of the habitable globe, existing in certain countries in a wild condition. Its original home is, however, quite unknown; and it is doubtful if any of the wild bees of this species are the descendants of primitively wild ancestors. In Southern Europe, as well as in China and Africa, varieties of the honey-bee are met with characterised by the presence of well-marked transverse bands on the body.

As is well known, the wax is secreted by the neuters, or workers, from between the segments of the abdomen. When secreting—a process which occupies about twenty-four hours—the workers cling to one another so as to form long festoon-like masses; the wax exuding as thin plates from between the abdominal segments. These plates are detached by the bees, and conveyed in fragments to the mouth, where they are masticated, and from which they finally issue in the form of a narrow white ribbon. To describe the manner in which the hexagonal-celled combs are built up from the wax thus formed, would be superfluous in the present article. Neither is it necessary to describe the collecting and melting down of the combs to form commercial wax. Nearly related to the honey-bee are certain smaller species inhabiting the warmer parts of South America, and referred to distinct genera, under the names of *Melipona*, *Trigona*, etc. These likewise build cells with wax, but whether in sufficient quantities to be of any commercial importance, we have not been able to ascertain.

The Chinese obtain a large quantity of excellent wax from an insect they term *pela*, which is a member of the order Rhynchota, and is technically known as *Ceroplastes sinensis*. This insect lives on trees, and is artificially propagated; its wax being employed for the manufacture of the candles used in the Buddhist temples of China and Japan, as well as for medical purposes. An allied species of wax-insect (*Ceroplastes ceriferus*) is found in Ranchi and other districts of India, clinging to the branches of certain kinds of trees, more especially the arjuse, a species of *Terminalia*. As is the case with the Chinese insect, it is the female alone which produces the secretion; this in the present case taking the form of small masses of pure white wax. The late Prof. V. Ball writes as follows concerning this species:—"The Indian wax-insect has never, I believe, been propagated, nor has the wild product ever been collected in quantity. It seems to be—although undoubtedly of value—a substance which would scarcely repay an expenditure of European time and capital; but were the natives to take up its cultivation they might very possibly make it a profitable undertaking."

Of very considerable commercial importance is the resinous substance known as lac, since it forms the foundation of most varnishes, and is also employed in the manufacture of sealing-wax, etc. It is the product of the lac-insect (*Carteria lacca*), an inhabitant of India and other oriental countries, and a near relation of the cochineal-insect, as well as a distant cousin of the plant-lice, or aphides. This insect gives rise to a resinous exudation from the bark of the trees it frequents, which, while still adhering to the twigs is termed stick-lac. When pounded and freed from colouring matter, this substance forms the seed-lac and shell-lac of commerce; while the liberated colouring matter constitutes lac-dye. As neither the resinous matter nor the dye are obtained from the body of the insect, they are not, properly speaking, animal products. Nevertheless, as they are caused by the presence of the insect, and are always spoken of in connection with the latter, they should be considered with such products.

Owing to sudden and large fluctuations in the price of lac in the London market, the trade is a somewhat risky one; the profits made in one year being not unfrequently swallowed up by the losses of its successor. Here it may be mentioned that the word lac, or lakh, is the Hindustani term for 100,000, and is applied to the insect on account of its numbers, while it is also in general use to denote the sum of 100,000 rupees.

The following account of the collection and manufacture of lac in the Ranchi district, India, is given by the writer just cited.* After mentioning that the lac-insect frequents the twigs of various jungle trees, and more especially three particular species, Prof. Ball proceeds as follows:—"To some extent the lac is found occurring, so to speak, spontaneously, and is collected by the forest tribes, and brought by them to the fairs and bazaars for sale. Where, however, there is a regular trade in stick-lac, propagation of the insect is systematically carried on by those who wish for a certain and abundant crop. This propagation is effected by tying small twigs, on which are crowded the eggs or larvæ of the insect, to the branches of the trees. These larvæ are technically called 'seed.' The larvæ shortly after sowing spread themselves over the branches, and, taking up positions, secrete round themselves a hard crust of lac, which gradually spreads till it nearly completes the circle round the twig. At the proper season the twigs are broken off, and we must suppose them to have passed through several hands, or to have been purchased directly from the collectors by the agents of the manufacturer. On arrival at the factory, they are first placed between two powerful rollers which, by a simple arrangement, admit of any degree of approximation. The lac is then crushed off, and separated from the woody portions by screening; it is next placed in large tubs half-full of water and washed by coolies, who, standing in the tubs, and holding a bar with their hands, stamp and pivot about on their heels and toes until, after a succession of changes, the resulting liquor comes off clear. . . . The lac, having been dried, is placed in long cylindrical bags of cotton cloth of medium texture, which are about

* "Jungle Life in India," p. 308 (1880).

ten feet long and two inches in diameter. These bags when filled have somewhat the appearance of an enormous Bologna sausage. They are taken to an apartment where there are a number of open charcoal furnaces, before each of which there is one principal operator with two assistants. The former grasps one end of the long sausage in his left hand, and slowly revolves it in front of the fire; at the same time one of the assistants, seated as far off as the sausage is long, twists it in the opposite direction. The roasting before the glowing charcoal soon melts the lac in the portion nearest the operator's hand, and the twisting of the cloth causes it to exude and drop into a trough placed below. The troughs which I saw in use were simply leaves of the American aloe. When a sufficient quantity in a molten condition is ready in the trough, the operator takes it up in a wooden spoon and places it on a wooden cylinder some eight or ten inches in diameter, the upper half of which is covered with sheet brass. The stand which supports this cylinder gives it a sloping direction away from the operator. The other assistant now steps forward holding a strip of the aloe between his hands, and with a rapid and dexterous draw of this, the lac is at once spread into a sheet of uniform thickness which covers the upper portion of the cylinder. The operator now cuts off the upper edge with a pair of scissors, and the sheet is then lifted up by the assistant, who waves it about a moment or two in the air, until it becomes quite crisp. It is then held up to the light, and any impurities, technically 'grit,' are punched out of the brittle sheet by the finger. . . . The sheets are placed in packing-cases, and when subjected to pressure break into numbers of fragments."

Previous to the discovery and extensive employment of aniline colours the substance known as lac-dye formed an important and valuable item among oriental animal products. As already mentioned, it is obtained by washing stick-lac in the course of its conversion into shell-lac. Unlike the latter substance it appears, however, to be of exclusively animal origin, being in fact the actual body of the lac-insect, and not a separate secretion.

In the manufacture of lac-dye in India the red liquor obtained from washing stick-lac is first of all strained through some textile fabric, in order to remove all portions of woody matter and other foreign substances. "It is then," to quote once more from Prof. Ball, "poured into large vats, where it is allowed to settle; the sediment is subjected to various washings, and at last allowed to settle finally, the supernatant liquor being drawn off. The sediment, when it is of the proper consistency, is placed in presses, from which it is taken out in the form of hard, dark, purple cakes with the manufacturer's trade-mark impressed upon them. By the addition of mordants this dark purple substance yields the most brilliant scarlet dyes, which are not inferior, I believe, to those produced by cochineal itself."

Of greater repute and of more importance than lac-dye is cochineal, which is the source of artists' carmine and carmine-lake, while when precipitated with a salt of tin, it also yields a splendid scarlet. The cochineal insect, of which the female, like that of the nearly allied lac-insect, alone yields the dye, is originally a native of Mexico, where it is parasitic on the leaves of the prickly-pear. The males of the *Coccus cacti*, as the species is called, are minute insects furnished with well-developed wings, feathered antennae, and a long pair of hair-like processes at the hinder extremity of the body. On the other hand the female is a repulsive-looking creature with very short posterior limbs, and is double the size of her partner. These insects adhere to the smooth surface of the fleshy leaves of the prickly-pear, and are not unlike small purple woodlice in general appearance.

The following account of the cochineal harvest is extracted from the English edition of Figuier's "Insect World." "These insects are collected when the females are about to lay, that is, when a few young are hatched. It is when the females are pregnant that they contain the greatest amount of colouring matter. When the harvest time has arrived, the cultivators stretch out on the ground pieces of linen at the foot of the plants, and detach the cochineals from them, brushing the plants with a rather hard brush, or scraping them off with a blunt knife. If the season be favourable, the operation may be repeated three times in the course of the year in the same plantation. The insects thus collected are killed by dipping into boiling water, by being put into an oven, or by being placed on a plate of hot iron. When withdrawn from the boiling water they are placed on strainers in an airy position, first in the sun, and afterwards in the shade. During their immersion they lose the white powder with which they are covered in life. In this state they are called *ronagridas* by the Mexicans. Those that have passed through the oven they term *jaspeadas*; these are ashy grey in colour, but those which have been placed on the hot plate become blackened, and are hence called *negras*. In commerce three sets of cochineal are recognised; first, the *mastique*, of a reddish colour, with a more or less abundant glaucous powder; secondly, the *noir*, which is large, and blackish brown in colour; and, thirdly, the *sylvestre*, which is smaller and of a reddish colour. This last description, which is gathered from wild cacti, is the most highly esteemed of all. Each year there are imported into France 200,000 kilogrammes of cochineal insects, which represent a value of about three million francs."

The cochineal trade is chiefly in the hands of the Spanish and the French. By the latter government these insects have been successfully introduced into Algeria, where they yield a large revenue. About the middle of the last century the government were accustomed to purchase the entire harvest, at the rate of fifteen francs the kilogramme. At a still earlier date they were introduced into the Canaries, where they have also become well established; but the attempts to acclimatize them in Corsica and the south of France resulted in failure.

In the early days of civilization, long before America was dreamt of, carmine was furnished by two European insects belonging to the family *Coccidæ*. The first of these is *Kermes vermilio*, the kokkos of the ancient Greeks and the kermes or alkermes of the Arabs and Persians. The females of this species are found adhering to the twigs of the kermes oak (*Quercus coccifera*), which grows in dry districts throughout most of the Mediterranean countries of Europe. On their native oaks the insects form dry brittle masses, which were (and perhaps still are) collected by the peasants in the south of France. When separated and completely dried, they are known as *graine de kermès*. In appearance they may be likened to purple currants; and when subjected to suitable treatment they yield a splendid red dye.

The second species is the Polish kermes (*Porphyrophyra polonica*), which once attained great celebrity under the name of the scarlet grains of Poland. The females of this insect frequent in great numbers the roots of a plant belonging to the genus *Scleranthus*, and are common in many parts of Poland and Germany, as well as in other districts of Central Europe. Towards the end of June the bodies of the females become greatly distended with a purple fluid; and it was at this time of the year that they were formerly collected in great numbers for the dyer. Now, however, they are superseded in commerce by cochineal and lac, although it is probable that their product is still employed to a certain extent locally.

An animal dye that has completely disappeared from use is the celebrated Tyrian purple of the ancients. Whether the dye, as originally manufactured, really had the splendid tint accorded to it by tradition, is unfortunately now impossible to determine. This dye is yielded by the common dog-winkle (*Purpura lapillus*), and may best be obtained by crushing the shell carefully and extracting the fluid from a white vein situated near the head. When first applied to linen this fluid makes a green stain, which if exposed to sunshine gradually changes to deep purple red. If the linen be washed with soap in hot water a further change to bright crimson will take place; this being permanent, without the aid of any mordant. Owing to the mixture of mucus with the pigment, linen dyed with it has always a blotched appearance; but whether the ancients had means of making the colour spread uniformly is not known. A purple dye may also be obtained from the posthorn pond-snail (*Planorbis corneus*).

The dark pigment sepia, which consists of the dried contents of the ink-bag of various cuttle-fish and squids, is on the other hand, an article of considerable value. It was formerly used as a writing fluid, and appears to have been employed in painting by the Chinese from time immemorial. Some years ago it was stated that the *sepia* of the water-colour artist was made of lamp-black; but although that substance may be employed for cheap imitations, the genuine article is still the product of the cuttle-fish and squid. Large quantities of the dried ink-bags of these molluscs are received by artists' colourmen for manufacture into sepia. And some firms regularly send their agents among the fishermen on our southern coasts for the purpose of collecting the ink-bags. These are saved by the fishermen when cutting up squids and cuttles for bait; and it has been suggested that the Newfoundland fishermen, who annually destroy a large number of these molluscs, might make a considerable revenue by saving and selling their ink-bags.

British Ornithological Notes.

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

WRYNECK CALLING IN AUGUST AND SEPTEMBER.—The Wryneck arrives here in large numbers about the beginning of April, and is heard constantly until the end of June or the beginning of July, but seldom later, although it remains with us until September. The latest date on which I heard one last year was July 3rd. This year I heard one as late as July 10th, as I thought for the last time this season, but a Wryneck was calling several times at one spot on August 19th, and since that date either a friend or myself heard the bird nearly every day up to September 10th, after which date it ceased calling.
BASIL T. ROWSELL, Guernsey.

Wood-Sandpiper in Co. Dublin (*Irish Naturalist*, October, 1901, p. 205).—Mr. W. J. Williams records that on August 19th he shot a Wood Sandpiper, in immature plumage, on a piece of marshy ground near Sutton, Co. Dublin. This is only the fifth specimen of this bird recorded from Ireland.

The Nesting of the Redstart and Willow Wren in Shetland in 1901 (*Annals of Scottish Natural History*, October, 1901, pp. 194-196).—Mr. Charles A. Sturrock gives an account of a pair of Redstarts which he found nesting at Spiggie, in Shetland. He also found two incomplete nests of the Willow Wren in the island. Neither of the birds seem to have been hitherto recognised as a breeding species in Shetland.

Lesser Tern Nesting at Barra (*Annals of Scottish Natural History*, October, 1901, p. 237).—Mr. W. L. MacGillivray writes that five pairs of Lesser Terns appeared at a small island off Barra on June 28th last, and eggs were found on July 9th. These birds nest on Tiree, but have not before nested on Barra, which is a decided westward extension of their normal range.

All contributions to the column, either in the way of notes or photographs, should be forwarded to* HARRY F. WITHERBY, *at 10, St. Germans Place, Blackheath, Kent.

Notices of Books.

"THE STALK-EYED CRUSTACEA OF BRITISH GUIANA, WEST INDIES, AND BERMUDA." By Charles G. Young, M.A., M.D., Dublin. Member of the Royal Irish Academy, lately of the British Guiana Medical Service. (London: John M. Watkins, 53, St. Martin's Lane.) 1900. Price 12s. 6d. net. Illustrated.—The plates, coloured from living specimens of tropical crabs, are an attractive feature of this volume. They are pleasantly suggestive of personal intimacy between the author and his subject. The numerous little "thumb nail" sketches of carapaces and other distinctive parts will be helpful to many readers. Those who avail themselves of Dr. Young's assistance for classifying collections from West Indian and the neighbouring waters will rejoice in the synoptic tables of families, genera, and species, which his book supplies. One could wish, indeed, that the present edition might be speedily bought up by those whom it is adapted to please and benefit, to make room for another on a different model. The book would have to be entirely re-cast to satisfy the requirements of the scientific student. In the first place, that exacting person would wish to pay less and receive more, and he could no doubt be gratified by a judicious treatment of the space and expenditure that have been devoted to the existing production. The luxurious printing of it is out of place in a manual. In a work of imagination by Pierre Loti it may be reasonable to separate one effort of genius from another by a large interval of blank paper. But no one wants to take a long breath between one borrowed description of a species and the next, or to turn over more pages than is absolutely necessary in searching for purely technical details. There are here no fanciful speculations, no original discussions, no amusing accounts of grotesque forms, queer habits, miscellaneous domiciles, to inveigle the general reader into enthusiasm for the study of these stalk-eyed creatures. What is offered is the dry light of science, and in this respect the enterprise of the publisher and the author's object are so commendable that fault-finding may seem ungracious. It is, however, very necessary with a view to any future improvement. From the plan of his work it was inevitable that Dr. Young should become more or less acquainted with the writings of many eminent carcinologists, and from the list of literature which he gives, his authorities can be traced as near to the present time as the year 1898. He might, therefore, be expected to adopt a fairly modern system of classification. What he does do, is to retain a sub-order "Anomoura" in its old extension, although the Dromiidea which he retains in it have for many years past been excluded from it by a consensus of the most trusted authors. By a procedure still less venial he upholds an order "Stomapoda" in what might be called a prehistoric or antediluvian acceptation of the term. If Latreille jumbled together the gentle *Mysis* with the piratical *Squilla*, at that early date there might be plenty of excuse. To wind up the nineteenth century by re-uniting them, when every possible sanction has been given to their separation, is a strange piece of business. In place of the Stomapoda, science has long acknowledged two very distinct orders, or sub-orders, the Stomatopoda, with its single family of the Squillidae, in which the branchiae are developed on appendages of the abdomen, and the Schizopoda, in which these organs of respiration (when present) are connected with members of the head and thorax. Of the second group, which is extremely interesting and diversified, Dr. Young mentions not one single example, nor even alludes to the fact that it is embraced in his definition of the sub-order. If, peradventure, his reading allowed him (wrongly) to infer a total absence of the [illegible] was [illegible] from West Indian waters, [illegible] cast for some [illegible]. As [illegible] remain among the S[illegible] half of which they have [illegible] nothing at [illegible], it must [illegible] synonymy is plotted out in an exasperating manner, as though the object were to cover as much space with as [illegible] as possible. Against the technical names the names of authors are given, but without dates, and often in [illegible], or at least unintelligible order, and without any indication of the work in which this or that author first defined this or that genus and species, or for any reason changed its original appellation. This method, or no method, may best be illustrated by an example, not selected, but taken from a casual opening of the volume. On page 94 we read:—

"*Mithrax* (*Mithrax*) *sculptus*.

" *Mithrax sculptus* . . . A. Milne Edwards, Gibbes.
" *Mithrax aunutus* . . . Saussure, Desbonne and Schramm.
" *Maia sculpta* . . . Lamarck.
" *Mithraculus coronatus* . White.
" *Mithraculus sculptus* . Stimpson.

A plain man would naturally infer from this that Alphonse Milne Edwards used the name *Mithrax sculptus* before it was adopted by Gibbes, and that Lamarck wrote at a later period than Saussure. It would be unfortunate for a plain man to back his inference by any large stake. Lamarck is the earliest author of all those mentioned in this list. Gibbes was anterior to Alphonse Milne Edwards. It was not Alphonse, but his father Henri who preceded Gibbes in calling the species *Mithrax sculptus*. Alphonse called it *Mithraculus sculptus* in agreement with Stimpson. Under the next species the synonymy gives "*Mithraculus cinctimanus*, A. Milne Edwards, Stimpson," though it was instituted by Stimpson in 1860, and not recorded by A. Milne Edwards till 187[illegible]. All this detail has been long ago worked out with care and minuteness, and stands recorded plain for all folk to see in the easily accessible "Proceedings of the U.S. National Museum" for 1892. It must rank among the curiosities of literature that anyone should attempt a compilation having for its subject American crustacea, and yet ignore or be ignorant of a whole series of writings by approved American authors on this very subject. The existence of Stimpson, as we have seen, is recognised. Acknowledgments are made to Miss Rathbun. Some of their writings are cited in the introductory list of literature. Others of equal importance are left unnoticed. But among those included in the list will be found Stimpson's "Notes on North American Crustacea," Parts I. and II. These are not voluminous contributions. Nevertheless, *Actaea erosa* from the coral reefs of Florida, *Clibanarius antillensis* from Barbados, and several other species therein described by Stimpson, are entirely passed over by Dr. Young, though proper to the region with which his book is concerned. That *Chlias limbatus*, from St. Thomas and other genera and species, instituted in the third part of the same series of notes, have suffered the same neglect, is perhaps most easily accounted for by the theory that Dr. Young never happened to have seen or heard of this third part. It would be tedious here to demonstrate the theory, but a student with patience to compare the two works in question is likely to become a believer in it. A similar theory will apply to the monographic paper on the genus *Panopeus*, by Benedict and Rathbun in 1891, to that on the Periceridae by Miss Rathbun in 1892, to the same writer's "Revision of the Nomenclature of the Brachyura" in 1897, as well as to Bigelow's "Stomatopoda of the 'Albatross'" in 189[illegible]. No writer could have willingly neglected the invaluable assistance of such contributions. The wonder is that any writer undertaking such a task as Dr. Young's could have escaped acquaintance with them. However, the sun still shines brightly when the spots on its face are dark and numerous, and no doubt the book under review, amidst its imperfections, contains a mass of sound information, and will be acceptable and useful to many. It is, in fact, good enough to make one sincerely wish that it were better.

"THE CAMBRIDGE NATURAL HISTORY: AMPHIBIA AND REPTILES." By Hans Gadow, M.A., F.R.S., etc. (Macmillan.) Illustrated. 17s. net. It may be truly said of this volume of a valuable series that it is the only thoroughly scientific and at the same time readable, up-to-date account of the living and extinct members of two very important and interesting groups of vertebrates. Dr. Gadow has devoted a great amount of attention both to reptiles and amphibians; and, as might have been expected, he has been led to introduce certain modifications in regard to the scheme of classification of the former group. No true conception of the mutual relationships of the existing groups of reptiles can possibly be entertained without including their extinct relatives, and the author is therefore to be congratulated on the large amount of space he has seen fit to accord to the [illegible] group [illegible] fauna of the [illegible]. [illegible] with regard to Huxley's proposal [illegible] on the one hand, [illegible] Although his [illegible] the most polite language [illegible]. And when the author [illegible] complete [illegible] between [illegible] that the extinct dinosaurs have [illegible] with birds. How intimate is the former connection in the author's opinion may be inferred by his proposal [illegible] hitherto classed with the labyrinthodont amphibians [illegible] reptiles. Neither does Dr. Gadow speak with any less uncertain voice as to the relationship between reptiles and mammals. [illegible] that reptiles are derived from the labyrinthodont or stegocephalous reptiles, he goes on to say that mammals trace their origin to some branch of the extinct anomodont theromorphous reptiles. As to birds, he believes them to have been evolved from some reptilian group at present unknown. The New Zealand tuatera lizard is regarded as the most primitive of all living reptiles, and from its ancestors are considered to be derived the snakes and true lizards. On the other hand, the ancestry of the chelonians and crocodiles is traced to the extinct anomodonts, which also gave rise to the dinosaurs and the great marine saurians of the secondary period. The importance of the anomodonts, some of which so strangely simulate the dentition of modern carnivorous mammals, can therefore be scarcely over-rated. In this connection it is a matter for regret that the recent discovery in Russia of many types of these anomodonts, previously supposed to be confined to South Africa, came too late to be mentioned. Although Dr. Gadow enters somewhat deeply into technical details, his language is for the most part so simple that it can be understood by any reader of average intelligence with a little trouble. One of the most generally interesting subjects touched upon is the history of the so-called giant tortoises of the oceanic islands. One of these, which was handed over to the British with the cession of Mauritius in 1810, still lives at Port Louis, where it was received first in 1766. The impending extinction of these large chelonians is much to be deplored. Less regret will be felt for the diminution in the numbers of the American alligator, which is now hunted both by whites and Indians for the sake of its hide. The numerous illustrations are all that can be desired, both from the scientific and the artistic point of view; a special feature being the introduction of small maps showing the distribution of various groups. Space, we regret to say, forbids a fuller notice. But it may confidently be said that by this work Dr. Gadow has decidedly enhanced his reputation as one of the foremost students and teachers of vertebrate zoology.

"THE LIFE AND LETTERS OF GILBERT WHITE, OF SELBORNE." Written and edited by his great-grand-nephew, Rashleigh Holt-White. (Murray.) 2 vols. Illustrated. 32s. Except for the brief memoirs in several of the many editions of Gilbert White's "Selborne" (notably that in Bell's edition), and for the life by Prof. Newton in the Dictionary of National Biography, there has been hitherto no connected account of the career of our best beloved naturalist. Although his life was singularly devoid of striking incident, so much interest attaches to White and his Selborne that we welcome an authentic record of his career, and further information regarding his country. Mr. Holt-White apologises for the fact that although not a naturalist himself he has undertaken to write the life of perhaps the best known naturalist, a fact which is responsible for a slight defect in these volumes, since a naturalist could have more clearly explained the value of White's observations, and traced their influence. To some extent this defect is compensated for by many interesting and valuable notes contributed by Prof. Newton. The author's immediate reason for publishing the biography appears to have been to correct many erroneous statements, some occurring in Bell's memoir, concerning the circumstances of the life of Gilbert White. These circumstances refer in the main to the naturalist's character and sentiments, and we need only remark that in our opinion Mr. Holt-White has completely abolished the misconceptions which have arisen. The biography consists chiefly of correspondence between White and his relatives and friends, and of extracts from the Garden and Naturalist's Calendars. Many of these letters have never before been published, and very few of those appearing in the Natural History of Selborne have been here reprinted. They are carefully arranged, and have been well connected and explained. They reveal a great deal of the character of the man, and tell us much that is interesting of his occupations, and of the manner of the life of his times. Although White never went out of England, as far as this country is concerned he was a considerable traveller for his age, and by no means the recluse that he is sometimes pictured. The correspondence with his brother John at Gibraltar reveals his keenness in detecting, even from a description, the nature of a bird or beast unknown to him and although his books on natural history were not many, those to which he had access were evidently well read. His love for Selborne and its fauna and flora was, however, the main theme of his life, and his happiest hours were undoubtedly spent in tending his garden, improving his "outlet," and above all in studying the birds, animals, and plants about him. Although he by no means disclaimed systematism it was as living and wild that he delighted to study nature. "Learn as much as possible the manners of animals, they are worth a ream of descriptions," he wrote to his brother at Gibraltar. We are very glad to have a more complete knowledge of the life of the first and greatest of field naturalists, and to be possessed of more of his charming letters. The volumes before us contain many nice illustrations, and we can only regret that no portrait of Gilbert White himself was ever made.

"THE NATURAL HISTORY AND ANTIQUITIES OF SELBORNE." By Gilbert White. Edited, with an introduction and notes, by L. C. Miall, F.R.S., and W. Warde Fowler, M.A. (Methuen.) 6s.—Although over 100 editions of White's Selborne have now been published, the demand for more will surely never fail. The editions lately published have generally possessed some special attraction in the way of illustrations or previously unpublished additions. The present edition contains no illustrations, and no novelty, but being well edited, neatly produced, and of a convenient size, it is none the less welcome. It contains the whole of the original edition of 1789, with the exception of the Appendix of Latin charters and deeds, while the "observations on various parts of nature," extracted from White's diaries by Dr. Aikin, are added. White's spelling and punctuation are "scrupulously retained." The editors have appended notes which are in every way exact and lucid. In the "letters" these notes are inserted wherever necessary, but in the "observations" a few more would have been advantageous, as, for instance, in the observation headed Grosbeak, where it should have been noted that the bird referred to was the Hawfinch. In an Introduction a brief account of the life and character of Gilbert White is given, which would no doubt have been enlarged and, in a few particulars, amended, had Mr. Holt-White's Biography, reviewed above, been accessible. Brief accounts are also given of the lives and works of Thomas Pennant and Dames Barrington, to whom the natural history letters were addressed, and of Richard Chandler, to whom were addressed the letters on the antiquities. The introduction contains besides, a short description of Selborne, and a history of the book itself. Finally, Mr. Warde Fowler contributes an admirable chapter, which is at once clear and brief, on White's view of the migration of birds. In this Mr. Fowler deals specially and with much skill with White's tendency to believe in the "hibernation" of birds. The spectre of "hibernation" haunted almost all White's observations on migration, and produced the only serious errors in his observations, and although he never was able to obtain proof of hibernation in birds his virtual belief in the myth has been undoubtedly the cause of its survival even to the present day. We may add that the present edition is nicely and clearly printed on a rough surfaced paper, which is so much more pleasant to the eyes and the touch than the highly glazed papers at present in vogue.

BOOKS RECEIVED.

Occasional Thoughts. By John R. S. Camp. (Simpkin, Marshall.)

Dragons of the Air. By H. G. Seeley, F.R.S. (Methuen.) Ill. 6s.

Elementary Telephotography. By Ernest Marriage, F.R.P.S. (Iliffe.) Illustrated. 3s. 6d. net.

Elementary Algebra. By C. H. French, M.A., and G. Osborn, M.A. (Churchill.) 1s. 6d.

The Growth of the Empire. By Arthur W. Jose. (Murray.) Ill. 6s.

First Year's Algebra. By C. H. French, M.A., and G. Osborn, M.A. (Churchill.) 1s. 6d.

Intermediate Practical Physics. By John B. Wilkinson. (Chapman & Hall.) Illustrated. 2s. 6d.

A Ready Aid to Distinguish the Commoner Wild Birds of Great Britain. By David T. Price. (Gurney & Jackson.)

Don Quixote. Vol. III. By Miguel de Cervantes Saavedra. Edited by Jas. Fitzmaurice-Kelly. (Gowans & Gray.) 1s. net.

Story of Fish Life. By W. P. Pycraft, F.Z.S. (Newnes.) Ill. 1s.

Zoology. By A. E. Shipley, M.A., and E. W. McBride, F.A., D.SC. (Cambridge: University Press.) Illustrated. 10s. 6d. net.

Story of the Isle of Man. By A. W. Moore, M.A. (Fisher Unwin.) Illustrated. 1s.

Scientific Roll. By Alexander Ramsay. (Sharland.) 1s.

Slide and Screw—being Notes on the Theory and Practice of the Game of Billiards. By C. D. Locock. (Longmans.) Ill. 5s. net.

Building Construction. The Organized Science Series. By Brysson Cunningham, B.E., A.M.I.C.E. (Clive.) Illustrated. 2s.

Practical Histology. By J. N. Langley, M.A., D.SC., F.R.S. (Macmillan.) 6s.

Unity of Matter. By Gustavus Detlef Hinrichs, M.D., LL.D. (St. Louis Mo., U.S. Carl Gustav Hinrichs.) $1 net.

The Play of Man. By Karl Groos. (Heinemann.)

Pharynx of the Eristalis Larva. By J. J. Wilkinson. (Clay.) Illustrated.

Report on the Scheme of Sewage Purification proposed for Belfast, and its probable Effects on the Lough. By E. A. Letts, D.SC., PH.D.

Vestments and Furniture. By Rev. F. C. Lambert, M.A. (Dawbarn & Ward.) 6d. net.

Climate and Weather of Sevenoaks. By W. W. Wagstaffe, B.A., F.R.C.S. (Sevenoaks: J. Salmon.)

Field and other Experiments at Rothamsted. By Sir J. Henry Gilbert, F.R.S. (Lawes Agricultural Trust Committee.)

Guide to the Collection of Minerals in the Blackburn Museum. (Blackburn: *Times* Office.)

Mr. H. J. Glaisher, of Wigmore Street, Cavendish Square, has sent us a useful catalogue of books, comprising details of an excellent collection of volumes, many of which refer to science.

NOTES.

ASTRONOMICAL.—In a recent discussion of data relating to solar radiation, Dr. Buchanan, F.R.S., concludes that under the most favourable circumstances the surface of the earth at sea-level receives heat from the vertical sun at the rate of 1.2 gramme degrees Centigrade per square centimetre per minute, or 1.17 horse-power per square metre. Taking into account the imperfect transparency of our atmosphere, the value of the *solar constant*, or the heating power of the sun's rays upon a surface of one square centimetre exposed to them for one minute at a point on the earth's orbit may perhaps be as much as 1.8 gr.° C. This result accords better with the older values obtained by Pouillet and Herschel than with some of the more modern estimates.

From a large number of measurements made with a filar micrometer on the 26-inch Washington refractor, Dr. See concludes that the diameter of the planet Mercury is 4277.6±5.8 kilometres; that is, 2656.4 ±3.6 miles. No markings of any kind were recognised with certainty, and no evidence of an absorbing atmosphere was obtained.

Continuing his interesting and suggestive researches on short-period variables, Dr. A. W. Roberts finds that the mean density of the eight known southern variables of the Algol type is 0.176, the density of water being taken as unity. Of the 22 "Algol" variables at present known, five, including β Lyrae, are regarded as binary systems in which the components revolve in contact. Such systems, however, are not permanent, the components diverging on account of tidal action. A regular sequence can be traced from binaries with a period of a few hours to those like Castor having a period of a thousand years.

The Board of Education has this year added "Spherical Astronomy" to the list of science subjects in which examinations will be held next May and June. The syllabus appears to have been carefully drawn up, and doubtless many students will be glad of the opportunity of obtaining certificates for this branch of astronomy. Descriptive and physical astronomy are included in the subject of Physiography, but a separate examination is held in Nautical Astronomy.—A. F.

Botanical.—In *Rhodora* for September, Dr. B. L. Robinson notes a case of "self-strangulation" in the Virginian Creeper (*Ampelopsis quinquefolia*). A tendril from the main stem had wound itself round a higher internode of the same shoot so tightly that further enlargement of the stem at this point ceased. Growth, however, continued above and below, resulting in a deep constriction in which the tendril was buried. In the following spring the part of the stem below the constriction developed leaves as usual, but that above showed unmistakable signs of death. Dr. Robinson remarks that on examining several plants of the Virginian Creeper, he found that it was not unusual for tendrils to attach themselves to the shoots that produce them, but without any injurious results.

Among the plants particularly noteworthy in the new part of *Hooker's Icones Plantarum* are: *Lepinia solomonensis* (Apocynaceæ), remarkable for its curious fruit, consisting of four carpels on very long, arched stalks, and connate at the apex; *Bretschneidera sinensis*, a handsome new genus of Sapindaceæ, from Yunnan, China, allied to the common Horse-chestnut, and named in honour of the recently deceased Dr. E. Bretschneider, author of the elaborate *History of European Botanical Discoveries in China*; *Urnularia*, a new genus of Apocynaceæ from Borneo, interesting on account of one of its species yielding, according to Professor Beccari, a good rubber; *Sympetalandra*, a somewhat anomalous new genus of Leguminosæ, also from Borneo; and the puzzling Mexican *Juliania*, which, though known to botanists for more than half a century, has not been definitely assigned to any natural order; its seed-vessels are singularly characterised by having three collateral or parallel cells.—S. A. S.

Entomological.—A fine male specimen of the "Timberman" Longhorn Beetle (*Acanthocinus ædilis*) has been sent to us for identification from New Seaham, Co. Durham, by Mrs. F. M. Stinley. It is a remarkable insect on account of the inordinate length of the feelers. Probably all the specimens which occur in England and Ireland are imported in timber from the north of Europe, but the beetle is believed to be truly indigenous in Scotland.—G. H. C.

Zoological.—Professor Ray Lankester's memoir on the affinities of the great panda (*Æluropus melanoleucus*) of Tibet has just appeared in the *Transactions* of the Linnean Society. It is illustrated by a beautiful plate of the under surface of the skull, displaying the remarkable character of the teeth. Almost synchronously with the appearance of the memoir the mounted specimen of the animal in the Natural History Museum has been placed in a case in company with its relatives, the long-tailed panda and the raccoons.

The October issue of the *Proceedings* of the Zoological Society contains Professor Lankester's diagnosis of the genus *Ocapia*, together with Sir Harry Johnston's account of how he obtained the okapi skin and skulls. A reproduction of the original sketch of the animal by Sir Harry, before the skin was mounted, accompanies the latter communication.

In the same periodical will be found an account of the rediscovery, by Mr. J. G. Millais, of Bechstein's bat in England. The first English examples of this species were taken many years ago in the New Forest; the specimen described by Mr. Millais was captured last March near Henley-on-Thames. This bat must now definitely be included in the British fauna.

Among other new mammals obtained by Sir H. Johnston in Uganda, Mr. O. Thomas describes in the same journal a handsome genet, for which the name *Genetta victoriae* is suggested. On another page Mr. Walter Rothschild mentions a series of magnificent specimens of the Abyssinian ibex (*Capra walie*) recently obtained by Capt. Powell-Cotton, one of which is now mounted in the Natural History Museum. Previously this splendid species was known only by the type specimens in the Senckenberg Museum at Frankfort and a few pairs of horns.

It seems as though we never should get to the end of changes in nomenclature. In a recent issue of the *North American Fauna*, now in course of publication by the Agricultural Bureau at Washington, it is proposed to replace *Mephites*, the well-known title of the true skunks, by *Chincha*; the former name being transferred to the little skunks (*Spilogale*). But there are worse things than this in nomenclature. In a notice of fossil remains from Patagonia, an Argentine writer proposes such unspeakable compounds as *Thomashuxleya*, *Gulielmoflowria*, *Oldfieldthomasia*, and *Asmithwoodwardia*. The only consolation is that they are not likely to come into use, as most, if not all, will probably turn out to be synonyms. Still, something ought to be done to stop such practices.

Not long ago Dr. D. G. Elliot, of the Field Columbian Museum, published a Synopsis of North American Mammals; this, in the Publications of the Museum, he has just followed with a revised list, containing additions and certain amendments in nomenclature. In another paper in the same serial he raises a protest against the excessive multiplication of specific and sub-specific names among the smaller American mammals. And in a third, throws doubts on the distinctness of some of the forms of caribou which have been recently named.

The last two numbers of the *Quarterly Journal of Microscopical Science* contain important papers by Mr. R. Evans on the Malayan representatives of that primitive arthropod *Peripatus*, together with remarks on the classification of the different generic types of the group.

In the October issue of the *Transactions* of the Zoological Society, Mr. G. A. Boulenger publishes his third contribution on the fishes collected by Mr. J. E. S. Moore in Lake Tanganyika. The whole collection has shown the striking fact that the peculiar beaked fishes forming the family Mormyridæ, so eminently characteristic of the fresh-waters of Ethiopian Africa generally, are unrepresented in Tanganyika. Another peculiarity is the occurrence in this remarkable lake of a representative of the Asiatic cyprinoid genus *Capoeta*, known elsewhere in Africa only by a single Abyssinian species.

The Inverness Earthquake.—It is seldom that earthquakes in this country are sufficiently strong to cause much damage to buildings. Within the memory of the present generation there have been only three—the Essex earthquake of 1884, the Hereford earthquake of 1896, and the earthquake that was felt throughout the north of Scotland shortly before 1.30 a.m. on September 18. There was no considerable destruction of chimney-stacks and roofs in the last case, such as occurred in the neighbourhood of Colchester in 1884, but it is said that few streets in Inverness have escaped some damage of a more or less slight character. Fissures in the ground are a rare result of British earthquakes, and it is therefore worthy of notice that one about 600 yards in length was formed in the north bank of the Caledonian canal at a spot a few miles from Inverness. The shock is said to have been felt at Dunbar, Wick, Tobermory, in the island of Mull, and at Aberdeen and Peterhead. Its disturbed area must therefore extend over the greater part of Scotland; and, since it includes Edinburgh (though no record has yet come from that city), it is strange that the shock should not have been registered by the seismograph erected in the Royal Observatory. The explanation probably is that, the boom of the pendulum being placed in a north and south plane, it would only be affected by movements with an east and west component.—C. D.

THE ALCHEMY OF HOAR-FROST.

By Arthur H. Bell.

Cooled surfaces are Nature's plates, upon which she etches some of her most beautiful pictures. In this artistic work she employs many materials, but her choicest effects are obtained through the medium of hoar-frost. Commonly, hoar-frost is described as being merely frozen moisture, but this is not an adequate description of an agent that has the power of adorning in a few hours such prosaic objects as gate-posts and dust-bins with all the trappings of fairy land. Moisture is indeed the fabric out of which all this feathery whiteness is built up, but, although it seems sometimes as if it is distributed in a very capricious manner, there are nevertheless certain definite circumstances which cause the hoar-frost to settle down on some surfaces rather than on others.

On any cold and frosty morning it will usually be found that those surfaces that are the best radiators of heat are also those that are most successful in collecting hoar-frost. It is not always realized, however, that all objects are continually radiating heat, so that no matter how much they may receive from the sun, they are constantly trying to get rid of it. A fern leaf, or a stone, may perhaps receive generous supplies of heat during the day, but as soon as night comes it hurries to spend or radiate it, and the object that is quickest at this work will the soonest become covered in hoar-frost. Everyone has observed how the moisture from the air will settle on the outside of a glass of cold water brought suddenly into a warm room. A similar process takes place in the open air, so that as the currents of moist air travel across surfaces that are very cold, they pay tribute in drops of vapour, which in warm weather take the form of dew, and in cold of hoar-frost. Moisture, therefore, plays a very important part in the development of these hoar-frost pictures; but there must not be too much of it. Some of the most delicate designs occur during the prevalence of mist and haze, and in towns especially it is no uncommon thing for a choking bituminous fog to be in some degree compensated for by a subsequent display of copious hoar-frost. As regards discovering what kind of surfaces are best adapted for collecting hoar-frost it may, in passing, be said that a very instructive and entertaining series of observations may be obtained by exposing to the frost cups, dishes, tumblers, saucers, and other glass and china ware, which will be found to accumulate hoar-frost in a varying degree. A brief contemplation of these differences will clearly demonstrate the fact that it is those objects that cool the quickest that make the speediest responses to the alchemy of frost.

In certain parts of the world agriculturists protect their crops from damage by frost by setting light to heaps of rubbish, thus producing clouds of smoke, which check the radiation of heat from the surface of the ground. By this means frosts are warded off and the life of susceptible plants is prolonged. A similar thing happens when real clouds float overhead, it being a common experience that no dew or hoar-frost forms when the night is cloudy. In other words, a canopy of clouds acts towards the earth as an overcoat and prevents the loss of the heat which it received from the sun during the day; for no sooner does this heat attempt to escape into space than the clouds reflect it earthwards again, and they form indeed a veritable trap for sunbeams. But when the air is damp and the stars are shining brightly, the thermometer at the same time being ten or more degrees below the freezing point, everything will be dusted over with fragile flowers of frost, and more especially if there happens to be little or no wind.

During very many years it has been a popular superstition that it is injurious to sleep with the moon shining on one's head. From what has already been said as to the way in which moisture promptly settles on all objects that are radiating their heat quickly, it will be gathered that it is not so much the moonbeams that work the mischief as the loss of warmth and the deposition of moisture which falls on all surfaces exposed to the sky on cold and cloudless nights, when dew and hoar-frost are most abundant.

It is, further, not commonly realized that the atmosphere acts as regards moisture very like a sponge. According to this conception of the case the air is not only able to absorb large quantities of water, but it is also able to retain it; and it is only when something happens to squeeze the atmosphere, as the process may be termed, that the hold on this moisture is relinquished. This squeezing of the atmosphere takes place whenever there is a fall in temperature, this being the great agent or force that precipitates the moisture from the air and causes it to take the form of rain, hail, snow, fog, dew, or hoar-frost; these various forms being regulated by the condition of the atmosphere. Although the air parts so readily with its stores of moisture when the temperature falls, it is to be observed that an increase of temperature greatly enlarges its capacity for moisture. A cubic foot of air having a temperature of 32 deg. can accommodate only 2·13 grains of moisture; but supposing the temperature to be increased to 72 deg. there would then be room for 8·47 grains. It will therefore readily be understood that in looking out for copious displays of hoar-frost, the best pictures will be observed if during moist weather a body of air having a high temperature is suddenly reduced to the freezing point.

One of the best ways of keeping a jar of water cool is to wrap a damp cloth round it; the evaporation of the moisture producing loss of heat. In hot climates this circumstance is, indeed, made of practical service as regards the manufacture of ice, for, so intense is nocturnal evaporation of moisture, that it is found that if water is placed in shallow porous pans overnight, there is a welcome supply of ice in the morning. When, therefore, moisture is evaporating into the atmosphere there is always a loss of heat, so that the greater the amount of vapour passing into the air the greater the amount of heat used up.

It is an interesting fact that when hoar-frost, or dew, or any of the other children of aqueous vapour, spring into being, this heat reappears, or, as it is sometimes conveniently described, latent heat is set free. As regards rainfall the amount of heat liberated is, of course, greater than is the case with hoar-frost. A fall of one inch of rain means that on every acre of ground a weight of one hundred tons of water has fallen, or 64000 tons to the square mile. Put in another way, this downpour over such a well known area as the Thames Valley means that [illegible] gallons of water have been precipitated from the atmosphere. It has been calculated that the condensation of one gallon of rain gives out enough latent heat to melt 75 lbs. of ice, or to melt 45 lbs. of cast iron. From these figures the mathematically inclined may work out for themselves the amount of heat set free in some tropical downpour when the rain instead of being an inch in depth, is seven or eight. That this liberated heat has great effects on the temperature and movements of the air goes without saying, but this part of the subject must not here be further pursued. It is now sufficient to say that just in the same way that condensing rain gives out heat, so do hoar-frost and dew, and a recognition of this fact has resulted in the suggestion of a rule for foretelling the occurrence of hoar-frost.

The success of this prognostic depends on the fact of there being an intimate relation between the deposition of hoar-frost and the temperature of the dew point, as it is termed. Reference was made above to the circumstance that the amount of moisture a given body of air can hold depends on its temperature. Thus at a temperature of 52 deg. a cubic foot of air is capable of giving accommodation to 4·39 grains of vapour, but at 32 deg. there is room only for 2·13 grains. If, therefore, a body of air at the former temperature is suddenly cooled, its capacity for moisture is correspondingly reduced and some of the aqueous vapour spills over, as it were, or is condensed. From this it will be seen that there is a critical temperature below which any vapour-laden air cannot be reduced without some of the moisture spilling over; this critical temperature being called the dew point. A glass of cold water (to repeat an illustration), when brought into a warm room, reduces the temperature of the air in contact with it to the dew point, so that drops of moisture form on the outside of the glass. Instruments that give the temperature to which the air is thus reduced are called hygrometers, and during frosty weather, as already suggested, a knowledge of this dew point may become exceedingly useful.

If, for instance, in the evening, the hygrometer shows the dew point to be above 32 deg., in the majority of cases there will be no hoar-frost that night. On the other hand, if the dew point is below 32 deg., and if there is a moderate amount of moisture in the air, plenty of hoar-frost may be expected. From what has previously been said it will be seen that this prognostic is capable of a very simple explanation. Latent heat is set free when condensation of moisture takes place, so that when the dew point is above 32 deg. any deposition of moisture results in a little warmth appearing, which is often quite sufficient to ward off hoar-frost. On the other hand, with a dew point below 32 deg., these hidden stores of heat are not sufficient to hold in check the advance of the icy spicules.

But probably the most interesting fact in connection with hoar-frost is its growth, it being no uncommon thing to see favourable surfaces literally submerged in a frosty mantle. Hoar-frost, moreover, is better suited by an atmosphere where moisture is plentiful than when it is not so abundant, these latter conditions being more favourable for the birth of dew-drops. Another consideration is that moisture may be reduced below the freezing point [illegible] then congeal [illegible]. It is a common experiment [illegible] though the slightest shaking of the [illegible] enough to change it promptly to [illegible]. So [illegible] regards the moisture in the atmosphere [illegible] reasons for supposing that in [illegible] the vapour may be a degree or two below [illegible] without actually solidifying, and [illegible] touch that will turn it into a feathery frond of [illegible]. Supposing, then, that moist air in this condition [illegible] wafted against a bush, a fence or a blade of grass, the shock, though slight, is quite enough to work [illegible] transformation. The greater part of these frost effects are thus prepared in the air, and as each body of chilled vapour floats against an object having already upon it a covering of frost, it is, as it were, roused by the shock, and awakening, promptly adds its load of frozen crystals to the growing picture.

◆

THE WATER OF THE DEAD SEA.

By C. Ainsworth Mitchell, B.A., F.I.C.

There are few more interesting sites in the world than the large lake which receives the waters of the Jordan. Its historic interest, the marvellous legends which were accepted and passed on by mediaeval travellers, its desolate position, and the remarkable character of its water have all helped to make it famous.

In the Bible it is called *The Salt Sea* and *The Sea of the Plain*, whilst among the Greeks and Romans it was known as *Lake Asphaltite* from the bitumen found floating on its surface. Its more modern name of *Mare Mortuum* or *The Dead Sea* is due to the absence of life in its waters and the scanty vegetation on its shores. Among the Arabs it is still known as *Baheiret Lût* or *The Sea of Lot*.

In shape it is an irregular oblong figure somewhat resembling a bow, the general direction of which is from north to south. On the east and west it is enclosed by ranges of mountains, which in places rise in sheer precipices from the water to a height of over 2000 feet. Josephus (Bell. Jud. IV. Ch. 8) gave its dimensions as 72 miles long by 18 miles wide, but explorations during the nineteenth century have shown that it is now only 46 miles in length by about 8 miles in width. Some contraction of the area has undoubtedly occurred, but even allowing for this the earlier estimate must have been too great. The surface of the water is more than 1300 feet below the level of the sea. The bottom is rocky and uneven, the northern part being very deep, whilst the southern section below the peninsula of Lisan seldom exceeds ten feet in depth.

The lake thus lies in a deep cavity, and being exposed to the burning rays of the sun, evaporation proceeds so rapidly as to more than counterbalance the influx of the Jordan. Incrustations of salts mark the higher levels reached by the water when the river is flooded.

To the south-west lies an extensive range of hills of rock salt, whilst sulphur mines are found on the west coast, and sulphur springs all along the shore. The origin of the asphalt which floats in masses on the water is attributed to the "slime pits" in the vale of Siddim (Gen. xiv. 10). This asphalt is driven by the wind to the western and southern shores, where it is still collected by the Arabs and sold for pitch and for medicinal purposes. According to tradition, it was used by the ancient Egyptians in embalming their dead.

The site of the cities of the plain has been placed by some in the northern, and by others in the southern part of the lake. Among the legends which were once commonly believed, was that the vestiges of Sodom and Gomorrah could be discerned centuries afterwards. Thus Josephus writes:—"The traces of the five cities are still to be seen, as well as the ashes growing in their fruits, which fruits have a colour as if they were fit to be eaten; but if you pluck them with your hands they dissolve into smoke and ashes."

The marshes adjoining the sea are very unhealthy, and malaria and fever are prevalent among the few tribes which dwell near them. Several explorers have lost their lives from the results of exposure and fever.

The water in mass is bluish-green and resembles sea-water. All accounts from Strabo to the present day agree as to its great density. Pococke, who bathed in it in 1743, found he could lie upon the surface without sinking. This characteristic has been so exaggerated by the earlier travellers that legends have attributed miraculous properties to the water. For instance, Sir John Maundeville in his Travels, published between 1357 and 1371, wrote:—"And neither Man, Beast, nor anything that beareth Life in him may die in that Sea. And that hath been proved many times by Men that have deserved to be dead, that have been cast therein and left there 3 Days or 4, and they might never die therein; for it receiveth no Thing within him that beareth Life. And no man may drink of the water for Bitterness. And if a Man cast Iron thereon it will float above. And if Men cast a Feather therein it will sink to the Bottom, and these be Things against Nature."

The first recorded analysis of the water was made in 1778 by Lavoisier by the then imperfect methods of analysis. He found it to contain 16.6 per cent. of solid matter, consisting of 40 per cent. of calcium and magnesium chlorides, and the remainder of common salt. Analyses have since then been made by Marcet in 1807, by Gay Lussac in 1818, and by T. and W. Herapath in 1850.

A specimen of the water, which I have recently analysed, was brought home some years ago by Mr. Boyle, a descendant of Robert Boyle's brother. It was given to me by his daughter, Mrs. Keely, to whom I take the opportunity of expressing my best thanks.

It was a yellowish dirty-looking liquid with an extremely saline taste. Its specific gravity compared with distilled water at 60° F. was 1.203, a result which agrees well with the figures obtained by Marcet (1.211) and by Lavoisier (1.2403). The variations being satisfactorily accounted for by the different period and distances from the mouth of the Jordan at which the samples were taken.

It is thus one of the densest natural waters known, its specific gravity far exceeding that of sea water, which only averages 1.027.

We may express these figures in other terms by saying that a gallon of distilled water weighs 10 lbs., a gallon of ordinary sea-water $10\frac{1}{4}$ lbs., and the same volume of Dead Sea water 12 lbs.

This accounts for the remarkable buoyant properties of the water, though obviously neither iron nor even aluminium with a specific gravity of only 2.6 would float upon it.

The great density of the water is due to the large quantity of saline matter in solution. The amount found by Lavoisier was doubtless considerably too high, for his analysis was made by the method of crystallization; and the results obtained by other chemists are in better agreement with the 24.46 per cent. which I have found.

The accumulation of salt must be attributed to the ceaseless evaporation of water and continual introduction of fresh supplies charged with salts from the surrounding strata. In sea-water the total salts only average 3.5 per cent.

This excess of saline matter has a very unpleasant effect upon bathers, and, according to Legh, produces a sort of temporary blindness. On leaving the water the skin is rapidly covered with a thin crust of salts.

On igniting the residue left on evaporating the water it darkened, owing to the combustion of the organic matter. This was present in considerable quantity (about 0.5 per cent.), and probably consisted of bituminous substances derived from the asphalt.

The chlorine amounted to 15.9 per cent., and in the residue was chiefly present in combination with magnesium, calcium, and sodium. The chief constituent of the water was thus magnesium chloride, which formed 9.06 per cent. of the total solid matter. In sea-water this salt is present to the extent of about 3.7 parts per thousand.

By combining the amount of sodium (3.35 per cent.) with its equivalent quantity of the chlorine, the amount of common salt in the water was calculated to be 8.52 per cent. It is thus much more than is present in sea-water, where it averages about 2.8 parts per cent. It is interesting to note, however, that whereas in sea-water the amount of ordinary salt is seven times that of the magnesium chloride, in the Dead Sea water they are present in approximately equal proportion. The calcium, which amounted to 1.3 per cent., was probably originally in combination with part of the chlorine, with the exception of a small quantity combined with the sulphuric acid as calcium sulphate or gypsum.

Bromine probably as magnesium bromide composed 0.24 per cent. of the water, and potassium as potassium chloride 1.20 per cent. Small quantities of iron, aluminium, and silica were also identified.

The calculated composition of the solid constituents of the water, excluding the organic matter, was as follows:—

	Per cent.
Magnesium Chloride ...	9.06
Calcium Chloride ...	3.19
Sodium Chloride ...	8.52
Potassium Chloride ...	2.37
Iron and Aluminium Chlorides ...	0.55
Calcium Sulphate ...	0.148
Ammonium Chloride ...	0.029
Silica ...	0.083
Magnesium Bromide ...	0.21
Total ...	24.460

Conducted by M. I. Cross.

THE MICROSCOPICAL EXAMINATION OF METALS.—It is a little singular that a study which has assumed such great importance as the examination of steel and iron under the microscope has done during recent years should not have received any treatment whatever in so exhaustive a work as the new edition of "Carpenter on the Microscope." It is a highly technical and important subject, and has become an absolute essential in all iron and steel works. In fact, there is probably no factory of standing that is not equipped with suitable instruments both for observing and photographing.

Although much information regarding the chemical constitution of the metal is disclosed by the microscope, it is in ascertaining the mechanical properties that the special value of the examination lies.

For instance, the structure of steel varies with the different degrees of hardness and the amount of heat to which it has been subjected, and it is possible to gain definite information concerning the suitability of the metal for the purposes for which it is to be used by means of the microscope.

In the manufacture of guns the microscope is invariably resorted to, and it can be definitely determined before the manufacture is proceeded with whether the metal is suitable for the purpose, or any defect has taken place in the heating or quenching which would render the gun unsafe or unsatisfactory.

Engineers can detect flaws, blow holes, defective welds, etc., and in many ways are able in an early stage to avoid the trouble incident to the use of imperfect metal in the finished article. Microscopes for the exclusive purpose require no substage apparatus or mirror, and although the complete stand is usually employed, the demand has become sufficiently marked for makers to produce special instruments in which a large mechanical stage is provided, but no fittings beneath the stage. Among these are Reichert, of Vienna, C. Baker, of London, and Queen, of Philadelphia. In all of these the vertical illuminator plays an important part; some observers preferring the pattern with a prism, others the cover-glass reflector, while many employ both, finding that each pattern is advantageous according to the structure examined.

When the light and illuminator have once been adjusted, it is important that no movement of the body of the microscope takes place, or the illuminating would have to be re-set. To obviate this, these special microscopes by Queen and Baker have rackwork focussing adjustment to the stage, together with levelling screws, so that any want of parallelism in the piece of metal may be corrected, and the face set at right angles to the plane of the objective. It will be seen from this that the subject has received careful consideration, and that suitable means are available for accurate work.

The metals themselves that are to be observed have to be prepared with great care; the processes are technical, and vary with the purpose of the examination. Generally a small sample block is taken, and cemented to a piece of glass. It is then ground and polished on a series of emery papers, and finally with a very fine polishing material such as rouge, until no scratches can be detected.

Although the harder portions can be in many instances seen at this stage, chemical means have to be resorted to, to differentiate the structure, the action being unequal on the different constituents, and it is by the treatment with such chemicals—nitric acid and liquorice juice being amongst the most important—that the chemical composition is detected. Many of the constituents have received distinctive names, among them being:—

Ferrite, which is the name given to pure iron.
Cementite, representing the iron carbide in steel.
Pearlite, a mixture of cementite and ferrite.
Martensite, the structure of quenched steel.
Austenite, a name given to structure which is produced in steel in which there is a high proportion of carbon.

There is vastly more to be learned of this interesting subject, and it is a field in which the amateur could with interest and profit make investigations.

A very full paper on the matter appears in the *Illustrated Annual of Microscopy of 1900*, by Mr. W. H. Merrett, to which I have referred for several of the foregoing details.

Multiplied Images in Diatoms.—Happening to hold a needle over the mirror of the microscope while a slide of Triceratium was under examination, I noticed that its point appeared dimly in each of the interspaces, and on racking the body of the microscope slightly upwards in the same manner as is necessary when observing the multiplied images in the cornea of the eye of a beetle, I noticed that it became distinctly sharp. I then placed a piece of black paper cut in the shape of a cross on the mirror, and with the same result the cross was sharply displayed, although on a much smaller scale than in the eye of beetle.

Experiments were then made with Coscinodiscus and other diatoms, and the same result was shown. This would seem to indicate that these interspaces are lenticular in shape, and it may be that with this knowledge further light may be shed on the complex question of the ultimate structure of some of the Diatomaceae.

Free Demonstrations in Micro. Manipulation. C. Baker's 1902 Catalogue. The newly issued edition of C. Baker's catalogue for the present season has been sent to me. The system of classification into separate parts, of microscopes and their immediate accessories, apparatus for collecting, bacteriological and blood examination apparatus, microscope specimens, etc., which made the previous issue of this firm's catalogue so useful for reference purposes, prevails in this new issue.

Apart from the very clear description of the many accessories which are required by the modern student, amateur or laboratory worker, there are one or two features of interest in their list which call for special notice on the part of microscopists generally.

On the first and third Friday and the second and fourth Tuesday in each month, from October to June, between the hours of 3 p.m. and 6 p.m., demonstrations will be given of microscopical manipulation. A syllabus has been prepared, and a series of six demonstrations is arranged to cover practical working with the microscope with modern accessories and by the latest methods.

I am not aware that any such provision has ever been made before, or classes held where such instruction as is now offered by Messrs. C. Baker could be obtained. It is particularly stated that "these demonstrations will be free to all, no charge of any kind whatsoever will be made, and no obligation to purchase is incurred by those availing themselves of this offer."

Another feature is the development of their Slide Lending Department, a system which, I believe, originated with this firm. They have had pamphlets and descriptions prepared to accompany the various slides which are lent on loan from them. These have been written by experts in the various subjects, and should be of great value to the private worker.

Catalogues of scientific apparatus nowadays are not so much mere price lists, but invariably contain a large amount of useful information and data, and are always handy for reference purposes.

This new catalogue is one that will be found especially practical, and microscopists should possess themselves of one.

NOTES AND QUERIES.

J. B. Morris.—There is no occasion to use balsam and shellac for fixing your rock sections to a glass plate during grinding. Canada balsam answers perfectly well if only it is used with care. The secret lies in the proper heating of the Canada balsam; if this is carried too far, it easily chips, and if not sufficiently it will not harden quickly. If you make further experiments, you will probably be more successful. There should be no air bubbles between the rock and the glass to which it is fixed; in the event of these appearing the process must be repeated. Balsam and shellac is used by optical glass workers, but as you would only want a very small quantity you could quickly ascertain suitable proportions; very little shellac would be needed.

W. H. Pownall.—The powers and numerical apertures of the Reichert objectives Nos. 3 and 6 are respectively [illegible]″ ·30, and [illegible]″ ·85. These are first rate lenses. The stand you mention is a very poor one, and you certainly cannot get the full benefit derivable from the objectives with such mechanical means. Swift's four-legged stand is a very good one and is conveniently portable. I do not think you could get greater value for your money from any other maker, and in my opinion this stand possesses many advantages over those made abroad and is decidedly preferable. If you care to send to the other houses you name for their catalogues, I shall be pleased to give you further advice should you require it, but you will be quite safe with the Swift instrument.

A. G.—The best and most comprehensive treatise you can have on the microscope and its general applications, including botanical matters, is the new edition of "Carpenter on the Microscope," edited by Dr. Dallinger, published by Churchill. If you require merely instructions in preparing botanical specimens, you will get this from "Modern Microscopy," published by Ballière, Tindall & Cox.

E. J. Hunt.—I have carefully examined the powder you have sent, but could find very few spicules. Sponge tissue, Xanthidia and organic remains generally, are constantly to be found in flint structure. It cannot be regarded as anything exceptional. With regard to the study of Mycetozoa, there is a small work by Sir Edward Fry and Miss Agnes Fry entitled "Mycetozoa, and some Questions which they Suggest," which you might find useful. It is a reprint of articles which appeared in KNOWLEDGE. You will also find the subject treated in a very interesting manner in the new edition of "The Microscope and its Revelations" (Carpenter), edited by Dr. Dallinger: in fact, information on nearly every subject of microscopical study is given in a practical manner in this book.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

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

THE GREAT COMET OF 1901.—Elements have been published in *Ast. Nach.*, 3734 and 3739, by H. Thiele, of Bamberg, and C. J. Merfield, of Sydney. The figures are nearly identical as follows:—

		THIELE. 1901, April 24·28845, Mean Time, Berlin.				MERFIELD. 1901, April 24·2526, Mean Time, Greenwich.		
T.		°	′	″		°	′	″
ω	...	203	2	15·1	...	203	2	14·8
☊	...	109	38	53·1	...	109	38	37·5
ι	...	131	4	49·3	...	131	5	40·0
log. q	...	9·38827			...	9·388907		

There is a possibility that the comet may be seen during the present autumn in some of the large telescopes now available to deal with such faint distant objects. At the beginning of November, 1901, the comet will be nearly stationary in the S.E. region of Cancer, and at a distance of about 300 millions of miles from the earth.

ENCKE'S COMET is now invisible to observers in the northern hemisphere, and, no other known comet being in view, there is really very little to observe in this department. With the exception of the fine object visible in the southern skies in the spring months, there have been no discoveries effected during the present year, and this is rather remarkable when we reflect that the number of comets is very considerable, and that several able observers are engaged in the systematic search for these bodies. Profs. Barnard and Swift (the latter a veteran of 81 years) have, we believe, relinquished comet seeking, but Brooks, Giacobini, Perrine, and others are actively prosecuting the quest, and we may probably, in the ordinary course of events, expect to hear of a discovery very shortly.

FIREBALL OF SEPTEMBER 14, 8H. 44M.—This was an unusually brilliant object, and its descent was witnessed over a large area. The sky was clear and moonless, the hour convenient, and the slow motion and dazzling lustre of the fireball attracted many surprised spectators to watch and record the apparition. In South Wales, and particularly in Pembrokeshire, the object presented a very striking display, and it is described as suddenly lighting up the sky and landscape with startling vividness. At Llandaff the meteor was estimated to be as bright as the full moon while at Ruabon it was thought to equal the half moon. Even as far distant as Chiddingfold, Surrey, Admiral Maclear describes it as intensely bright, while Mr. T. H. Astbury, at Wallingford, Berks., says it appeared much brighter than Venus. The meteor passed over the Bristol Channel, beginning its luminous career when over a point a few miles off Lynton and Ilfracombe, and travelling to north-west it crossed Pembrokeshire, finally disappearing near St. David's Head. It fell from 66 to 26 miles in height along a visible course extending over 83 miles, which it traversed with a velocity of about 20 miles per second. But the various estimates of the duration of flight are, as usual in such cases, very inconsistent. Two of the observers give 2 seconds, while one gives 30 seconds, and another 1 minute! In deriving the velocity it has therefore been found expedient to adopt the mean of a few of what are obviously the best determinations, and these indicate 4 seconds as approximately the duration. A hissing or whirring sound is stated in two cases (St. Clears and Llanwrda) to have accompanied the meteor as it penetrated the atmosphere, while at Little Haven, situated near the terminal point of the flight, Mr. J. Phillips reports a distinctly audible booming sound, which came about three minutes after the nucleus had disappeared. Mr. J. Halton, of Manchester, says the nucleus seemed to plough its way through the atmosphere as though strongly resisted. Mr. Hilditch, of Newport (Mon.), remarks that the object was so luminous and apparently so near that he thought it must have fallen to the earth within a few miles to the north-west of Newport. As a matter of fact, however, the meteor was more than 100 miles distant from this town at the time of its disappearance. Had the object been enabled to withstand disruption during a further interval of about three seconds in which it might have traversed the 56 miles separating it from that point of the earth's surface upon which it was directed, it would have fallen in the St. George's Channel, a few miles off Wexford, on the south-east coast of Ireland.

The meteor left a bright train in its wake, but it quickly died away. Several of the observers were at first impressed with the rocket-like appearance of the object and thought it a brilliant firework, but soon after realised the celestial character of the startling visitor.

The radiant point of the meteor was at 345° + 1° near β Piscium, and situated between the constellations of Pegasus and Aquarius. There was a brilliant fireball on 1875, September 14, from a radiant at 348° ± 0°, and it appears to have unmistakably belonged to the same system as that which supplied the similar object seen on September 14th last. The shower is a notable one, for its visible activity is prolonged throughout the months of August and September, and it occasionally furnishes fireballs of the largest class.

THE FACE OF THE SKY FOR NOVEMBER.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 6.56, and sets at 4.32; on the 30th he rises at 7.45, and sets at 3.53. There will be an annular eclipse on the 10th 11th, which, however, is invisible at Greenwich; the central line passes from the Mediterranean across Arabia, Ceylon, and Siam.

THE MOON.—The moon will enter last quarter on the 3rd at 7.24 A.M., will be new on the 11th at 7.34 A.M., will enter first quarter on the 19th at 8.23 A.M., and will be full on the 26th at 1.18 A.M. Some of the 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. 3	A² Cancri	5·8	5.32 A.M.	42	17	5.59 A.M.	1	0	21 17
„ 4	ω Leonis	5·6	0.4 A.M.	44	79	0.30 A.M.	348	27	22 11
„ 24	ο Arietis	5·8	3.15 P.M.	29	65	3.49 P.M.	304	339	13 8
„ 25	B.A.C. 1240	5·7	8.11 P.M.	117	155	9.0 P.M.	218	252	14 13
„ 27	71 Orionis	5·4	10.41 P.M.	12	49	10.54 P.M.	350	26	16 15
„ 29	68 Geminorum	5·0	7.18 A.M.	142	102	8.6 A.M.	251	210	18 12
„ 30	κ Cancri	5·0	9.51 P.M.	46	84	10.21 P.M.	341	20	19 14

THE PLANETS.—Mercury is in inferior conjunction with the sun on the 4th, and will afterwards be a morning star, at greatest westerly elongation of 19° 42′ on the 21st. The times of his rising from the 16th to the 24th, compared with that of the sun, are as follow:—

Date.	Mercury rises.	Sun rises.	Interval.
			H. M.
November 16	5.27 A.M.	7.22 A.M.	1 55
„ 18	5.26 A.M.	7.25 A.M.	1 59
„ 20	5.28 A.M.	7.29 A.M.	2 1
„ 22	5.32 A.M.	7.32 A.M.	2 0
„ 24	5.38 A.M.	7.35 A.M.	1 57
„ 26	5.44 A.M.	7.38 A.M.	1 54

On the 16th the planet will be nearly S. west of α Librae, and will pass about 2° north of that star on the 25th. During this time the planet will set about 20° south of west.

Venus is an evening star, setting about 6.22 P.M. on the 1st, and about 7.4 P.M. on the 30th. At the middle of the month about six-tenths of the disc will be illuminated, and the apparent diameter will be 20″.6. The planet will be low down in the south-west after sunset. She will be in conjunction with Jupiter on the 18th, and with Saturn on the 19th.

Mars may be considered not observable.

Jupiter remains an evening star, setting on the 1st about 7.50 P.M., and on the 30th about 6.21 P.M. Under favourable atmospheric conditions the following satellite phenomena may be observed:—

		H. M.			H. M.
2nd.—	II. Sh. I.	5 35	10th.—	I. Tr. E.	5 22
	III. Tr. E.	6 8		I. Sh. E.	6 24
	II. Tr. E.	6 [illegible]	11th.—	II. Ec. R.	5 49
	I. Ec. R.	7 11	13th.	III. Ec. R.	4 48
	III. Sh. I.	7 23	17th.—	I. Tr. I.	5 4
9th.	I. Oc. D	5 47		I. Sh. I.	6 1
	II. Tr. I.	6 3	18th.—	I. Ec. R.	5 29
	III. Tr. I	7 13	20th.—	III. Oc. R.	5 8
				III. Ec. D.	5 35

Saturn is also an evening star, setting on the 1st about 8.7 P.M., and on the 30th about 6.26 P.M. The most notable phenomenon in connection with this planet during the month will be its conjunction with Jupiter on the 28th; this will be the closest conjunction of the two planets which has occurred since 1683, and it will not be until 1961 that there will be another opportunity of observing the two planets in the same low-power field. Mr. Crommelin has calculated the following data for the conjunction:—

Date Noon	Diff. of Long.	Diff. of Latitude Jupiter South		Distance of Centres	Elongation from Sun
Nov. 21	45.2 West	26	33	52	45
„ 23	33	26	31	42	43
„ 25	21	26	30	33	41
„ 27	7.6	26	29	27	39
„ 29	5.1 East	26	28	27	37
Dec. 1	18	26	27	32	35
„ 3	31	25	26	41	34
„ 5	44	26	25	51	32

Uranus is approaching conjunction with the sun and cannot be observed.

Neptune is well placed throughout the month, rising on the 1st about 7.18 P.M., and on the 30th about 5.22 P.M. The path of the planet is a short westerly one in the western part of Gemini. On the 1st the planet is 3½m. preceding and 17′ south of η Geminorum; on the 30th the distances are respectively 6m. and 17′.

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 will occur on the 3rd at 9.52 P.M.; on the 6th at 6.21 P.M.; on the 23rd at 11.15 P.M.; on the 26th at 8.4 P.M.; and on the 29th at 4.53 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.

No. 1.

(N. M. Gibbins.)

1. B to Ktsq, and mates next move.

No. 2.

(B. G. Laws.)

Key-move. 1. R to R4.

If 1.	P to B4,	2. Q to B3ch
1.	P to Q4,	2. Q to B5ch.
1.	Kt to K4,	2. Kt to K2ch.
1.	Kt × P,	2. Kt × Ktch.
1.	K moves,	2. Kt to Q2ch.

It is unfortunate that the second solution by 1. R × Pch is so obvious. Mr. Laws' problems have been very unlucky in Knowledge this year.

Correct Solutions of both problems received from J. Baddeley (6), G. W. (6), G. W. Middleton (6), W. H. S. M. (6), S. G. Luckock (6), W. Nash (6), W. Jay (6), G. Groom (6), A. C. Challenger (6), J. E. Broadbent (6), C. Johnston (6), F. Dennis (6), Vivien Macmeikan (6), H. Le Jeune (5), W. de P. Crousaz (5), Major Nangle (5), C. C. Massey (5), W. H. Boyes (5).

Of No. 1 only from G. A. Forde (Capt.) (2), W. Clugston (2), A. E. Whitehouse (2).

Of No. 2 only from Alpha (3).

Alpha.—In No. 1, B to Kt6 is answered by P to Kt4 only.

Major Nangle.—Thanks for the problem, which is, however, too elementary for publication.

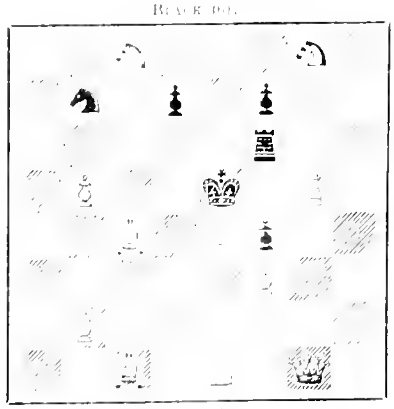
A. E. Whitehouse.—Kt to KR5 does not appear likely to solve No. 2. How, for instance, does White proceed if Black plays 1. ... K to Q4?

PROBLEMS.

No. 1.

By W. Clugston (Belfast).

Black (6).



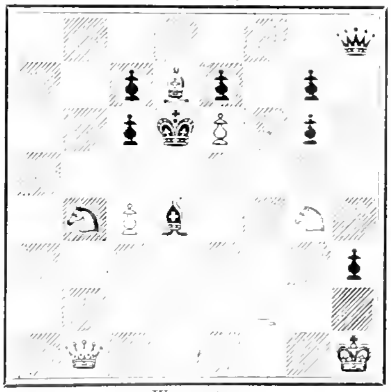
White (7).

White mates in two moves.

No. 2.

By D. L. Anderson.

BLACK (9).



WHITE (8).

White mates in three moves.

The leading scores in the Solution Tourney are now as follows:—

Fifty-six points.—A. C. Challenger, W. Jay, C. Johnston.

Fifty-five points.—F. Dennis, G. Groom, S. G. Luckock, W. H. S. M., G. W. Middleton.

Fifty-four points.—J. Baddeley.

Fifty-three points.—G. W.

Fifty-two points.—J. E. Broadbent, H. Le Jeune, W. Nash.

Fifty-one points.—W. de P. Crousaz, Vivien H. Macmeikan.

Forty-nine points.—C. C. Massey.

All these sixteen may be proud of the fact that there are fifty scores below theirs.

The following game was played in the Monte Carlo Tournament:—

"SICILIAN DEFENCE."

WHITE. G. Marco.	BLACK. J. Mieses.
1. P to K4	1. P to QB4
2. KKt to B3	2. P to K3
3. P to Q4	3. P × P
4. Kt × P	4. QKt to B3
5. Q Kt to B3	5. Kt to B3
6. KKt to Kt5 (a)	6. B to Kt5
7. P to QR3	7. B × Ktch
8. Kt × B	8. P to Q4
9. P × P	9. P × P
10. QB to B4	10. Castles
11. B to Q3	11. B to Kt5 (b)
12. P to B3	12. B to R4
13. Castles	13. B to Kt3 (c)
14. B × B	14. RP × B
15. B to Kt5	15. Q to Kt3ch
16. K to R1	16. Q × P
17. B × Kt	17. P × B
18. Q to Q2	18. Q to Kt3
19. Kt × P	19. Q to Q1
20. QR to Q1 (d)	20. K to Kt2
21. Q to B4	21. Kt to K4
22. Q to QKt4 (e)	22. R to R1
23. P to KR3	23. Q to QB1
24. Q to K7	24. Q to KB1
25. K to Kt1	25. QR to K1
26. Q × KtP	26. R × P (!)
27. P × R (f)	27. Q to Kt4ch
28. K to B2 (g)	28. Kt to Q6ch
29. R × Kt	29. Q to R5ch
Resigns.	

NOTES.

(a) Black has played the old-fashioned form of the defence, but there is nothing to be gained by this attack, even when followed by the comparatively modern 7. P to QR3, instead of the useless check with the Knight. The best move is 6. B to K2.

(b) To check with the Rook would probably only induce the Knight to play to K2, on its way to KB5.

(c) It would be too risky to win a Pawn at once: *e.g.*, 13. . . Q to Kt3ch; 14. K to Rsq, Q × P; 15. Kt to Kt5, shutting in the Queen.

(d) The result of White's combination is that he, instead of his opponent, has now the isolated Pawns, and is, moreover, compelled to make a defensive move. The Black King is perfectly safe.

(e) Kt to K3 suggests itself here. White's next move is lamentably weak, and prepares the way for Black's brilliant sacrifice.

(f) It is not absolutely necessary to take the Rook, Kt to K3 or P to KB4 might give chances.

(g) 28. K to Rsq is compulsory here, in order to avoid any check from the Knight. If then 28. . . Q to Kt6, 29. Kt to B4 (threatening Kt to R5ch), 29. . . Q × Kt, 30. Q to Kt4, Q to B4, and the game is still difficult to save.

CHESS INTELLIGENCE.

The Albin-Marco match at Carlsbad has resulted in a win for Herr Marco by 4 games to 2, the remaining 4 games being drawn.

Mr. A. F. Mackenzie, the blind composer of Jamaica, has established a record by carrying off the first three prizes in the three-move sui-mate tourney of the *British Chess Magazine*. He has also won the first two prizes in the *Birmingham Post* three-move direct-mate tournament.

It is probable that international tournaments will be held during the coming season at Monte Carlo, Berlin and Hanover. Another interesting event will be a match between the British Chess Club and the Dutch Chess Association.

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

The yearly bound volumes of KNOWLEDGE cloth gilt, 8s. 6d., post free.

Binding Cases, 1s. 6d. each; post free, 1s. 9d.

Subscribers' numbers bound (including case and Index), 2s. 6d. each volume.

Index of Articles and Illustrations for 1891, 1892, 1894, 1895, 1896, 1897, 1898, 1899, and 1900 can be supplied for 3d. each.

All remittances should be made payable to the Publisher of "KNOWLEDGE."

"Knowledge" Annual Subscription, throughout the world, 7s. 6d., post free.

Communications for the Editors and Books for Review should be addressed Editors, "KNOWLEDGE," 326, High Holborn, London, W.C.

KNOWLEDGE
AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

VOL. XXIV.] *LONDON DECEMBER, 1901.* [No. 194.

CONTENTS.

EDITORIAL.

BEFORE proceeding to outline briefly our programme for the new year, the pleasing duty again devolves upon us of acknowledging our indebtedness to our Contributors for the very thorough manner in which they have enabled us to fulfil our promises, and to add still another volume of KNOWLEDGE to the series. To this expression of our thanks, we add an appreciation of the steady and increasing support which our Subscribers have given to our efforts to make KNOWLEDGE a trustworthy and popular medium of scientific thought.

In a day when the spread of science and literature has given the public a well-nigh limitless supply of new and remarkable facts, it is regrettable that the true meaning of these facts is too often hidden from the public view by the reserve of specialists. It is our earnest hope, therefore, that an increasing number of those who have it in their power to stimulate and satisfy the desire for a clear and definite perception of the worth and large issues of scientific discovery may be induced to do so.

The increasing public interest in the study of Astronomy, to which we referred last year, has been evidenced in the interest aroused by Mr. Maunder's comprehensive "Constellation Studies"; the concluding paper in this series will appear in the January issue, when the whole twelve studies, together with the previous series on "Astronomy without a Telescope," will be carefully revised by the Author prior to their issue as a volume in the KNOWLEDGE Library. Mr. Maunder is also engaged on a new series of papers dealing with some of the results of Spectrum Analysis.

Among the other Astronomical projects for which arrangements have been now completed, we may mention a descriptive account of the Starfield Observatory from the pen of Dr. Isaac Roberts, to whose work Astronomers are so much indebted; a paper on the Spectrum of Nova Persei, by the Rev. W. Sidgreaves, S.J.; and two articles from Mr. A. C. D. Crommelin, who proposes to deal with Eclipse Cycles, and with the actual path of the Moon in space. Further interesting contributions are promised by some writers new to our pages, and among these we may mention the Rev. T. E. Phillips on "The Currents of Jupiter's Atmosphere"; Professor R. A. Sampson on "The Almucantar of Durham Observatory," and on "The Mechanical Constitution of the Sun"; and Mr. Alexander Smith on "The Methods, Difficulties, and Results of Stellar Photography."

Mr. W. F. Denning will continue to contribute "Notes on Comets and Meteors"; while "The Face of the Sky" will appear month by month as heretofore, but will be edited during the coming year by Mr. W. Shackleton.

We are happy to welcome back to the pages of KNOWLEDGE an old friend in the person of Mr. E. A. Butler, who will commence in the January number a series of illustrated entomological articles. In Botany, Mr. R. Lloyd Praeger will contribute a new series of papers, of which the first will deal with "Plant Colonists"; and the Rev. Alex. S. Wilson will write on "Vegetable Mimicry." Much interest has been aroused during the past year by the Rev. J. M. Bacon's balloon expeditions, and Mr. Bacon has promised to write for us on "The Air above London," and on "The Clouds as seen from Cloud Level."

The Rev. T. R. R. Stebbing informs us that the fulfilment of his promise to write on some singular groups of *Arthropoda* may be regarded as still in view, the promise not forgotten, though the fulfilment has been deferred. Prof. Grenville A. J. Cole will return to our columns with an article on the great granite chain of south-east Ireland, "The Backbone of Leinster"; and he will also write on "The Plain of Prussia." Mr. Harry F. Witherby will record his experiences on an ornithological expedition to Russian Lapland. Contributions have also been promised by Mons. E. M. Antoniadi, Mr. R. Lydekker, Dr. Hugh Robert Mill, and other writers.

Mr. M. I. Cross will continue to conduct the Microscopy column. This subject could be made increasingly helpful and interesting by the co-operation of readers and workers, and notes and suggestions are invited. It is proposed at intervals to offer to readers of KNOWLEDGE material for mounting as microscopical slides, with instructions for the processes, and descriptions of the objects. It is hoped that readers will themselves contribute material for distribution with descriptions, and so add to the usefulness of the suggested scheme.

In the Chess Column, the Solution Tourney which Mr. Locock has conducted during the closing year has proved an unqualified success, and has induced Mr. Locock to project for the new year a three-move Problem Tourney and also a Solution Tourney to run concurrently with it. The particulars of both these contests will be found in the Chess Column.

It will be gathered from the foregoing that a large part of our volume for the coming year is provided for, but we are always glad to receive contributions considered suitable for our pages.

THE WHITE NILE—FROM KHARTOUM TO KAWA.

AN ORNITHOLOGIST'S EXPERIENCES IN THE SOUDAN.

By HARRY F. WITHERBY, F.Z.S., M.B.O.U.

VI. A DANCE, A SAND-STORM, AND A RARE BIRD.

THE natives, generally, as I have mentioned, took little notice of us. One day, however, when out collecting, we met with a flattering reception from the inhabitants of a small village through which we passed. The men rushed up to us, seized our hands and kissed them repeatedly; while the women in the background gazed on us admiringly and loudly proclaimed their pleasure with the shrill "sachareet." The "sachareet" is a loud high-pitched trill, sounding like the syllable "la" uttered very rapidly and shrilly, and is used by the Soudanese women on all joyous occasions. We were somewhat overcome and greatly puzzled by this greeting, and suspected that it was due to something more practical than pure good nature. The country round the village proved a good collecting ground, and the next day we went there again, and as the place was some distance from our camp we carried luncheon with us. The natives seemed even more pleased to see us than they did the day before. However, as we were bent on collecting, we paid little attention to them, and leaving a couple of men to prepare luncheon in the shade of some thick bushes, we set out to hunt the surrounding country.

On returning in the heat of the day to the temporary camp amongst the bushes we found all the inhabitants of the village engaged in a dance. On our appearance the dance stopped, and our ears were split with the shrill sachareet; the natives crowded round, and we were nearly overpowered by the coarse and pungent odours from the pomades and scents with which the women plaster themselves, especially on festive occasions. Getting the crowd to stand off a little we asked our men the meaning of all this hubbub, and learnt that a wedding was shortly to take place in the village.

We were then led to an open space amongst the thick mimosas, and while the old men and children carefully cleared the sand of the long white thorns, the matrons arranged the scanty clothing of the young girls and made them ready for the dance. All being prepared, we sat down on the sand, and the natives arranged themselves in a semi-circle in front of us. Behind stood the old women, and in front of them the young men and girls; while the old men and children grouped themselves in various attitudes at each side. Of musical instruments there were none, not even a tom-tom, but time and incentive were given by a somewhat droning chant accompanied with clapping of hands. As yet there seemed no inclination to dance, and a nudging and pushing in the ring of singers indicated unwillingness on someone's part to perform—what woman does not understand the value of coquetry? At length a girl was pushed out of the ring, but she coyly darted back, only to be pushed out again. Then, standing upright for a moment, she began the dance. Putting one bare foot forward and throwing her head right back, with her full bosom thrust out and her hands on her hips, she slowly advanced, swaying from side to side and turning and moving her head in time to the music. Every movement was slow and careful as though the dance was a difficult balancing feat, and the performance reminded one of the strutting and nodding of an amorous pigeon. Behind the girl walked a young man, clapping his hands in time to the chant, while both he and the dancer uttered an extraordinary guttural grunting sound which seemed to arise from the very depths of the stomach. The girl stopped in front of us, and still swaying her body, gradually sank down at my feet, then, slowly rising, swished my face with her plaited, grease-soaked hair. Feeling considerably embarrassed, and not knowing what was expected of me, I asked my men quickly to tell me what to do, as the girl was preparing to repeat the perfumed swish. They told me to flick my fingers at her and bend my head to hers. Thankful that nothing more was expected, I did this as well as I could, and immediately all the women set up the shrill sachareet and the dancer returned to her place. Evidently I had done the right thing, but I believe one is also expected to damp a coin and place it on the dancer's forehead. The dance now became more general, several girls performing, and all of us being saluted. A gourd was then brought round and we were told that a collection was being made for the bride and bridegroom, who by the way were nowhere to be seen, the bride being carefully locked up until the wedding day, and the bridegroom being too bashful to appear. The gourd so far only contained a few beads. We contributed the little money which we had about us, but felt that the wedding presents were meagre. Our men gave nothing, although they immensely enjoyed the dance. Moreover, when pressed, they swore repeatedly and solemnly that they had no money.

These dances are kept up night after night for a week or so before a wedding. John Petherick, in his "Egypt, the Soudan and Central Africa," mentions that jars of merissa are supplied free to entertain the wedding guests. Our men told us that merissa was to be had in plenty during these times of gaiety, but that the visitors had to pay for it, and the knowledge of this fact and the handing round of the begging bowl somewhat detracted from the wild freedom of this primitive scene.

There are many curious customs in connection with marriage amongst the Soudanese. One of a primitive and savage nature was brought to our notice continually. At almost every camp young men were conducted to us to exhibit with great pride long raw wounds on their backs. In every case these wounds were made with the corbag and were inflicted at weddings. Part of the ceremony consists in the bridegroom standing erect and motionless while one of the party flicks pieces of flesh off his back with this deadly whip. Should he move or betray any sign of pain he is considered no man, everyone jeers at him and a crowd of contemptuous hags rush on him, their nails proving often worse to endure than the corbag.

For two hours after we had got rid of the dancers an almost overpowering smell of ointment hung heavily in the air, and we were only too glad to cut short our mid-day rest and resume collecting. Hearing at some distance a loud wild whistle somewhat like that of a buzzard, I followed up the sound and tried to get near the bird that made it. But it was a long chase. The country was fairly open and the bird very shy, so that it managed easily to watch me and with heavy dipping flight to keep well out of range. At length, however, a wooded place gave me the advantage, and after a short stalk I secured the bird, which proved to be a dark-coloured hornbill.* Most of the hornbills, as is well known, are characterised by an exceedingly large bill, the upper part of which is thickened to such an extent

* *Lophoceros nasutus* (Linn.).

as to form a sort of casque, and the whole is usually brilliantly coloured. The bird I had just secured had a large heavy curved bill, but the casque was small and scarcely noticeable, while in colour the bill was black. A smaller species* of hornbill, which was fairly common in the district, also had a comparatively slender bill, but coloured more brightly with red, black and yellow.

These curious birds were, unfortunately, not breeding at the time of our visit, so that we were unable to observe the remarkable habits, shared, I believe, by all the hornbills, of imprisoning the female in the hole of the tree in which the eggs are laid. When the female begins to sit the male proceeds to plaster up the entrance to the nest with a gummy secretion, and his mate is no unwilling party to this arrangement, for she actually helps him in the work. It is probable that while she is sitting she loses all her wing feathers and is thus incapable of flight. If such be the case her prison may well become a fortress, where she is safe from the attacks of monitors and other enemies. A crack is left open in the plaster door and through this the male feeds the female and the young. Even more remarkable than the imprisonment of the female is the fact discovered by the late A. D. Bartlett, that at a certain period of the year hornbills cast the lining of their gizzards. The lining is formed by a secretion, and takes the shape of a bag, the mouth of which is closely folded. When cast up the bag contains the fruit which the bird has been eating, and it is supposed that this process enables the male to provide his mate more easily with food.

The pursuit of the hornbill had led me far from the camp, and the keenness of the chase had made me oblivious to a dark heavy cloud on the horizon. I knew well what the cloud meant. It drew rapidly nearer and I walked quickly on, but was still some way from the

The Wreck of a Tent. Waiting for the Sandstorm to clear.

tents when there was a sudden roar of wind, then fell darkness, and the air, laden with sand, became blinding and suffocating, blotting out the country like a thick mist. To try and proceed meant losing oneself in this fog of sand. To face the wind was to court blindness, and there was nothing to be done but to crouch down back to the driving cutting sand and wait for the storm to clear. Gradually the air got clearer, and with the darkness gone but with the wind still blowing, I made my way to camp. The storm produced the usual uncomfortable results: clothes and body seemed saturated with grit; boxes and trunks, however tightly closed, were filled with sand, and meat and drink that night were thickly seasoned with it. When a storm was accompanied by a heavy rush of wind the results were more annoying. Clothes and papers were scattered, and once my tent blew down with a run, burying my camera and myself in the ruins. The only benefit bestowed by a sand-storm was an occasional cool wind which followed, but this was, unfortunately, rare, and scarcely compensated for the two or three hours of misery the storm entailed.

As a rule an approaching dust-storm appeared merely as a thick murky cloud, but once from the top of Gebel Auli we witnessed a storm advancing upon us over the desert like a huge tidal wave. Towering some two or three hundred feet in the air, and stretching away almost to the horizon on either side, the great wave curved like a gigantic bow. Its centre was a shapeless mass of inky blackness, but where the bow curved and the brilliant sun lighted up the wave in profile, its form was as compact, well defined, and rounded as any Atlantic breaker, and its colour of a rich deep yellow. Rolling over and over and advancing slowly but certainly it seemed as though it might sweep everything from the face of the earth. In front all was bright and peaceful, behind all was dark and gloomy. Suddenly we heard the roar of the wind, a few moments more and the wave was on us, its outline faded and we were engulfed in the thick darkness and driving sand. An hour or two afterwards we emerged from the shelter of a rock and made our way to camp, and all that night we slept in a wind that was delightfully cool but heavily charged with sand.

Sand-spouts, dust devils, or "cock-eyed-bobs" were other forms of sand-storms which caused us much amusement. A little whirlwind suddenly starts in the desert raising a small column of dust. The column whirling spirally upwards rapidly increases both in height and circumference. Then it begins to move along and at length tears madly across the plain as if alive, gathering pace and volume as it goes and whirling aloft every loose thing it encounters. At all hours of the day these spiral columns of sand race over the desert, stopping here and there, then rushing on again. They vary as much in their size as in their direction. Sometimes two will meet each other, and if they be well matched the collision stops them, and a struggle ensues as to which way they shall twist. Gradually one gains the mastery, and the two combined begin to gyrate alike and then rush on together. A dust devil comes on you unawares and sweeps off your hat and an Arab's clothes. I have seen one twist a goat round like a top, and our camel men were once attacked and their loose clothes swept off, while we, only fifty yards away, heard the roar but felt not a breath of wind.

The wildness, the freedom, and the limitless extent of the desert all have their charms, the scent of its heated breezes is fascinating, while its very barrenness has an intense interest. Compare the vegetation of a

* *Lophoceros erythrorhynchus*, Temm.

desert to that of a well-watered country. In the desert the plants fight for life against the want of moisture; they are thinly spread, stunted, with small leaves or no leaves, spiky or hairy, every contrivance being made use of to prevent transpiration and to retain moisture. In the watered country the plants fight against one another, they crowd each other out, and the most luxuriant gains the mastery. In the desert you can read in the sand as in clearest print and see the scarcity of its animal life. Bordering on the watered country the tracks are fairly numerous, but the further you go the fewer become the feet-marks until those of sand-grouse and a few other birds with here and there a run of some small animal are all the marks to be seen.

One afternoon while wandering about the fringe of the desert I came upon some tracks made by small birds which seemed to be great runners. I followed up the spoor until it disappeared, evidently where the birds had taken to flight. Going on and casting about I found the tracks again and eventually got a sight of some sandy-coloured babblers‡ running swiftly along the ground. When I neared them they uttered a shrill "whee" quickly several times, then rose and flew straight and low, alighting some little way off. After hunting them a long time and getting no nearer, I at last drove them into some thick leafless bushes. I could see them from the distance with my binoculars perched in the bushes and flirting their tails up and down like wagtails, but when I got near they had disappeared. Then I heard a shrill note coming from the middle of a bush which was composed of thin and wiry green shoots, leafless but so thickly interlaced that the birds were perfectly hidden. I kicked the bush, but the birds would not budge. I walked all round it several times but the birds only travelled round on the opposite side. When I was least expecting it the babblers flew out suddenly and silently, and were hidden in a neighbouring bush before I could get a view of them. By employing dodging tactics somewhat like hunting a person round a table I managed to secure two or three specimens.

The chase ended, I began to realise that six or eight miles of desert divided me from the river; that I had no water bottle and was parched with thirst. The east grew dark, and turning round, I saw the sun quickly dipping below the horizon. I hurried to the river but had not gone a mile before the sun sank, and the light rapidly drawing itself together, plunged down after it, the landmarks disappeared, and I was left without a guide. I trudged on and luckily keeping my direction fairly well, at length reached the trees. After a long search I found the camp, but was then nearly speechless with thickened tongue and parched-up throat. Such a condition was uncomfortable enough, and gave one a slight idea of the agonies suffered by those who die of thirst in the fiery heat of the desert.

The chief object of this walk in the desert was to search for a rare and beautiful goatsucker.§ Only four specimens of this bird were known and they had been brought home many years ago; three by Rüppell and one by either Schimper or Baron von Müller. The exact locality from which they came was uncertain, but it was known to be from somewhere in the Sennaar district. Consequently the bird was one of our possible prizes and was hunted for accordingly. The plumage of the head and back of this lovely goatsucker is like burnished gold with small spots and bars of black and grey, while the breast is buff coloured. A bird of such colouring should evidently live amongst yellow sand, but the desert for the most part of the country we traversed was of a gritty grey colour. It was not until we were within twelve miles of Khartoum on our return that we found the desert of a colour to match the goatsucker. But all our search was useless. The goatsucker was not to be found by tramping over the burning sand. Then good fortune came to our aid.

There is just a short half-hour after sunset when the bats begin to fly and one can see to shoot them against the fast waning light in the west. On one of our last evenings of camp life I was trying to shoot some small bats that were flitting round the tents. The first that dropped I failed to find in the darkness, so I marked the place where it seemed to fall by a small pyramid of mud. By this time the sun's glow had faded, but a brilliant moon had risen, and thinking I should be able to see the bats flying over the water, I moved down to the edge of the river. As I was standing there a hawk-like bird appeared like a ghost from over the river. As it passed me I raised my gun mechanically and fired, but the bird went on and in ten yards or so was out of sight. I thought no more about it as my gun was loaded with dust shot and the bird seemed large and some distance off. Tiring at length of shooting by moonlight I returned to the camp, and calling for a lantern, went to search for the bat at the place I had marked with a heap of mud. As the light flashed on the spot, there lying dead with outspread wings was the glorious golden goatsucker. I picked it up and rushed madly to my companions. The Arabs looked on in wonder at three frantic Englishmen dancing and shouting round a bird. It was one of those rare occasions in a naturalist's camp when champagne would seem a necessity. Having none we drank to the goatsucker in whisky and White Nile water.

That night we heard a goatsucker "churring." We hoped it might be a golden one, but could detect no difference in its note to that of the common goatsucker of the country, which rasped continually like some huge locust in the trees about our camps. Needless to say in the few days before we reached Khartoum and began our rush home to England, we redoubled our efforts to find more of so rare a bird, but not a sign of another did we see. In a country made easily accessible by rail such a bird cannot be expected to remain rare long, and this year, near Shendy, the Hon. Charles Rothschild and Mr. A. F. R. Wollaston found this goatsucker fairly common, and brought home some fifteen specimens.

The fate of the bat that led to the finding of the goatsucker must be told. In the morning I searched carefully and found it. Strangely enough it was of much the same colour as the goatsucker, and on bringing it home Mr. W. E. de Winton pronounced it a new species. My friend, Capt. S. S. Flower, however, afterwards brought home a similar specimen which he had obtained two months before I shot mine, and some 200 miles further to the south. Capt. Flower's specimen therefore rightly took precedence, and the bat has been named *Glauconycteris Floweri*.

I often dream of a broad river flowing through a desert land lit by the bright moon; of a ghost-like form and a chance shot; then I see a stately Arab bearing a lantern, and suddenly the light flashes upon a glorious bird shining like burnished gold all spread out upon the sand.

‡ *Argya acacia* (Licht.).

§ *Caprimulgus eximius* Temm.

A REMARKABLE MAMMAL.

By R. Lydekker.

My readers are not to imagine that the animal whose portrait appears in this number of Knowledge is one new to science, or even one whose structure has hitherto been imperfectly known. On the contrary, it has been known to science for nearly a century and a quarter; but it is altogether such a peculiar and interesting creature that it may well form the text of an article in this journal.

Like so many of its cousins the lemurs, the aye-aye is an inhabitant of Madagascar, from the west coast of which island the first specimen known to European science was brought to Paris in 1780 by the French traveller Sonnerat, who discovered several other curious mammals and birds. By the naturalists of that time, despite the remarkable peculiarity in the structure of the fore-paws mentioned later on in this article, it was regarded as a squirrel, and accordingly named *Sciurus madagascariensis*. It was, however, soon after apparent that, whatever might be its real affinities, it could not rightly be retained in the same genus as the true squirrels; and it was accordingly renamed, at first *Daubentonia*, and subsequently *Chiromys* (*Cheiromys*). The justification for the proposal of this second title was that the first had been previously employed in botany, which was then (although not now) regarded as a bar to its use in zoology. And at the present day some naturalists think that the almost forgotten *Daubentonia* ought to be resuscitated, and the familiar *Chiromys* abolished. This, however, is a matter which may be left for the specialists to settle among themselves.

But it is not with regard to its scientific name alone that the creature has been unfortunate; a difference of opinion having arisen as to its right to the name "aye-aye," by which it has been universally known since Sonnerat's time. That traveller, it appears, had at first two living specimens obtained on the west coast of Madagascar; and when these were seen by the natives of the east coast (where the species is unknown), they ejaculated "aye-aye"—or more probably "hai-hai"—which seems, not unnaturally, to have been regarded as the native name of the animal. At least as early as 1860 it was, however, suggested that in place of being the animal's name, it was merely an exclamation of surprise at the sight of a strange and unknown creature. And this view of the case is maintained to be correct by Mr. Shaw, a missionary who resided for many years in Madagascar. On the other hand, another missionary, Mr. Baron, affirms that the name "hai-hai" is derived from the creature's peculiar cry.

When those who have the best opportunities for deciding arrive at such opposite conclusions it is difficult for others to form a judgment. I have, however, consulted a naturalist familiar with Madagascar, who tells me that "hai" is undoubtedly the Malagasy expression of surprise or wonderment. And that as the aye-aye is a shy and rare creature, seldom seen even by the natives of the districts where it is found, and then regarded with superstitious awe, the colloquial expression of wonderment may well have become its accepted name. If, however, "hai-hai" be, as Mr. Baron asserts, the creature's own cry, then it would seem more likely that the exclamation has been derived from the animal, and not that the animal has taken its name from the exclamation. Anyway, there seems undoubtedly to be some kind of connection between the exclamation "hai-hai" and the name "aye-aye," and we may therefore be convenient to accept the latter as the popular title for *Chiromys madagascariensis*. The naturalist to whom allusion is made above tells me, however, that the creature certainly has another vernacular title in some parts of the island.

As already mentioned, the naturalist Gmelin, by whom the aye-aye was originally described, regarded it as a kind of squirrel—an opinion shared at first by the great anatomist Cuvier. This view of its relationship was doubtless formed from the somewhat squirrel-like appearance of the animal, and the approximation made by its teeth to the rodent type. When, however, the Paris specimen was more carefully examined, and its skull and certain other bones removed from the skin, it became apparent that its relationships were evidently with the lemurs; the German naturalist Schreber being the one to whom the honour of this identification is due.

From Schreber's time till 1860 little or nothing more was done to advance our knowledge of the aye-aye, of which the Paris specimen remained the only example in Europe. In 1858, however, Dr. Sandwith left England for Madagascar, and previous to his departure Sir Richard (then Professor) Owen impressed upon him the importance of endeavouring to obtain specimens of this rare animal. A year later the Professor received a letter stating that, with much difficulty a specimen had been secured; and this in due course arrived in England preserved in spirit. It was dissected and described by Owen in 1860; and from the beautiful drawing by Wolf which accompanies that memoir the figure illustrating the present article is reproduced.

Soon after the arrival of the specimen sent to Owen a living example of this strange animal was received at the menagerie of the Zoological Society in Regent's Park; this being a female presented in 1862 by Mr. E. Mellish. An excellent account of the habits of this animal in captivity was published by the late Mr. A. D. Bartlett in the Society's *Proceedings* for the same year. A male and female were also received in the menagerie in the summer of 1883, while a fourth specimen was purchased in the autumn of 1887.

The ordinary public saw, however, little or nothing of these specimens, for as might be inferred by its large eyes, the aye-aye is essentially a nocturnal creature, remaining comfortably curled up during the daylight hours, and only venturing out as the darkness comes on. In this respect it resembles the majority of its cousins, the lemurs; and were we naming animals afresh, the title lemur would in some ways have been more appropriate to this particular species than to those to which it properly belongs. For the word "lemur" in its original signification means a ghost, and not only is the aye-aye stealthy and ghost-like in its movements, but it is regarded with superstitious dread by the Malagasy, who believe it to be a kind of spirit.

As already mentioned, the aye-aye has somewhat the appearance of a large dark-coloured squirrel; and in size it may be compared roughly to a cat, the total length being about three feet. The head and face are short and rounded; and the large eyes are furnished with a membrane which can be drawn across them from one side. The large and rounded ears, which are inclined backwards, are naked and dotted with a number of small tubercles. The blackish-brown hair all over the body is long and coarse, but it becomes longer still on the long and bushy tail. Nothing very remarkable exists in the structure of the hind limbs, which somewhat exceed the front pair in length; but the fore-paws, or hands, which are unusually elongated, display a most strange peculiarity. As in lemurs generally, the thumb is capable of being opposed to the index finger, which is short; the latter, together with the fourth and fifth digits, being of normal thickness and provided with long compressed and pointed claws. The third, or middle finger, as is beautifully shown in the plate, is, however, quite unlike the others, being extremely thin and spider-like. Of its use, mention will be made later.

This attenuated middle finger is one of two marked peculiarities whereby the aye-aye differs so strongly from its relatives, the true lemurs. Its other peculiarity is to be found in its dentition. Ordinary lemurs, it may be observed, have from 32 to 36 teeth; the incisor, or front teeth, although presenting certain peculiarities of form, agreeing numerically with those of monkeys and man in most cases. In the aye-aye, however, there are only 18 teeth, all told; the incisors being reduced to a single pair in each jaw, the canines, or tusks, wanting, and the cheek-teeth, or grinders, comprising four pairs in the upper and three in the lower jaw. Nor is this all, for the incisors, which grow throughout life, are large somewhat chisel-like teeth, recalling in many respects those of the beaver, or other rodents, although with peculiarities of their own which render them easily distinguishable from those of all the members of that group. Still, the whole character of the dentition is so essentially rodent-like that there is little wonder the old naturalists regarded the aye-aye as a near relative of the squirrels.

The general anatomy of the aye-aye, especially the structure of its skull, shows, however, that it is certainly a near relative of the lemurs, themselves distant cousins of the monkeys, from which, among many other peculiarities, they differ by their expressionless, fox-like faces. The aye-aye is therefore classed as a lemuroid; of which group, owing to the peculiar character of its dentition and its attenuated middle finger, it must be regarded as a highly aberrant and specialised member.

Unfortunately, in spite of recent explorations in the superficial deposits of Madagascar, where bones of huge extinct lemuroids have been disinterred, nothing whatever is known as to the ancestry of the aye-aye. Evidently, however, it must be a comparatively ancient type, for, if we may judge from the analogy of other groups, a long period of time must have been required to allow of the gradual evolution and development of its characteristic peculiarities of dental and manual structure.

Clearly these peculiarities must be connected with its mode of life. And we learn from those who have observed the creature in its native forests or in captivity, that the aye-aye, unlike the true lemurs, subsists largely upon wood-boring insect larvæ, especially on the larva of a beetle known to the Malagasy by the name of andraitra. Apparently the aye-aye possesses a sense of hearing so acute that when on a bough it can detect the faint rasping sound made by the jaws of the andraitra as it bores its way through the wood in the interior. Thereupon it at once sets to work with its powerful front teeth to chisel away the intervening wood till it opens up the tunnel of the burrowing larva. As soon as the tunnel is opened up the attenuated middle finger is thrust in, either to act as a probe to determine the position of the larva, or to drag it out from its hiding place, or perhaps for both purposes. Some uncertainty still obtains as to the exact details of these and other operations of a like nature, for our information on these points appears to be mainly, if not exclusively, based on native accounts. There is, however, little doubt that the *modus operandi* is in the main as described above.

We thus have a sufficient and satisfactory explanation of the reason why the aye-aye differs so remarkably in its dentition and in the structure of its hand from all its living kindred. If, however, we attempt to account for the gradual development of these peculiarities by what is commonly called natural selection, we encounter considerable difficulty. It is easy to conceive how the ancestors of the horse may have lost their lateral toes by disuse, but how an ancestral aye-aye gradually reduced the size of its middle finger till it assumed the attenuated proportions of its existing representative is very hard to understand, seeing that a slight diminution in the calibre of this digit would be of little or no advantage. Some much more potent cause than "natural selection" seems necessary in this, as in many other instances.

As regards its general mode of life, the aye-aye wanders through the silent forests at night in pairs, and never appears to associate with others of its fellows than its partner. Probably the partnership is for life, but on this point we have no definite information. The aye-aye is one of the comparatively few mammals which build a regular nest; this being constructed, according to Mr. Baron, of the carefully rolled up leaves of one particular kind of tree, and lined with small twigs and dry leaves; the whole structure having a diameter of about a couple of feet. Apparently the sole use of this nest is a nursery, and in it at the proper season the female brings forth a solitary offspring; whether born naked or clothed with hair does not seem to be ascertained. The female alone builds the nest, which is placed securely in the fork of a tree. In addition to the use described above, the attenuated middle finger is employed to comb the hair and clean the eyes, mouth, and nose; when thus engaged the animal generally suspending itself head-downwards from a bough by its hind-feet—at any rate, this is the case in captivity. Generally the food is not held in the paws after the usual monkey and lemur fashion, although the act of drinking is performed in an ape-like manner, the fingers being first dipped in water and then sucked.

In addition to the boring larvæ already alluded to, it is certain that the aye-aye will eat various other kinds of food, although native accounts differ to a considerable extent on this point. Some say, for instance, that it subsists largely on birds and their eggs, while others assert that honey is its favourite food. Probably there is some degree of truth in all these accounts, and that the creature is to a certain extent omnivorous. It will eat sugar-cane with considerable gusto, and in captivity has been known to take bananas. But that these latter are not its natural food would seem to be evident from the fact that they stick in and clog its teeth.

As regards its distribution, the aye-aye is a very local animal; its chief habitat being the great forest clothing the eastern border of the great central plateau of the island. Here, however, it is apparently restricted to the district forming the confines of the provinces of Sihanaka and Betsimisaraka, which is situate about five-and-twenty miles inland in latitude 17° 22′ S. I am, however, informed by the friend mentioned above that an aye-aye occurs in the south of the island, which, if its habitat is isolated from that of the typical form may turn out to be a new local race, or possibly even a distinct species.

HEAD AND FORE-QUARTERS OF THE AYE-AYE.

The Most Remarkable of the Malagasy Lemuroids

From the Drawing by Wolf, published in the *Transactions of the Zoological Society of London.*

Although the aye-aye is certainly far from being a common animal, yet it is probably less rare than is often supposed. Its supposed great rarity appears to be largely due to the dread in which it is held by the natives, who can seldom be induced to capture a specimen. It is believed to be endowed with the power of causing the death of those who attempt its capture, and it is consequently only some of the bolder natives who will venture on this undertaking, and then only after providing themselves with a charm to counteract the effects of the creature's supposed supernatural power. Occasionally, according to Mr. Baron's account, it is taken in traps set for lemurs; but it is then, unless the owner is possessed of the aforesaid charm, invariably set at liberty, after being anointed with fat in order to propitiate its goodwill and forgiveness. Only very occasionally is a specimen offered for sale in the market at Tamatave, when a good price—presumably from Europeans—is always obtained.

THE REAL PATHS OF FIREBALLS AND SHOOTING STARS.

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

DURING the fifteen years from 1886 to 1901 the real paths of 300 fireballs and shooting stars were computed by the writer. The observations were principally made at Bristol, at Slough by Prof. A. S. Herschel, and at Bridgwater by Mr. H. Corder. Simultaneous watches of the sky were arranged between these and several other observers in various parts of the country for the special purpose of obtaining duplicate records of identical meteors, and those who participated in the work having been habitually engaged in this field, it is thought the data which have accrued may be regarded as fairly accurate. Most of the results of individual path-computations have been already published in the Journals of the Liverpool Astronomical Society (1887-9) and British Astronomical Association (1892-1901), the work having been in part undertaken in connection with the meteoric sections of the societies named.

I have been arranging and classifying the results with the object of deriving mean values for the various kinds of meteors, as the materials appear to be sufficiently ample to allow figures to be arrived at which, if not conclusive and final, will at least approximately represent the facts and possibly lead the way to a more thorough investigation at a future time when many thousands instead of a few hundreds of trustworthy observations of this kind have accumulated. The mean heights, etc., are summarized in the following table:—

	Mean height at beginning.	Mean height at ending.	Mean length of path.	Mean velocity per sec.	Mean altitude of radiant.	No. in diagram.
	Miles	Miles	Miles	Miles	Degs.	
FIREBALLS—						
Very swift, with streaks, Perseids, Orionids, Leonids, &c.	85·2	50·0	55·0	37·5	39	1
Moderately slow, with tolerably high radiants	71·7	23·3	84·0	18·3	35	2
Slow-moving low radiants	58·4	26·0	116·0	14·6	16	3
Slow-moving, radiants close to horizon	58·4	47·6	121·4	13·0	5	4
SHOOTING STARS—						
Very swift, with streaks, Perseids, Orionids, Leonids, &c., radiants pretty high	80·7	55·7	42·5	41·0	36	5
Very swift, with streaks, radiants low	73·8	63·5	53·9	39·0	11	6
Rather slow, high radiants	67·1	47·4	27·2	19·3	57	7
Slowish, low radiants	60·2	51·3	35·5	17·4	15	8

The following conclusions have been drawn from a study of the results and from an examination of other materials of similar character which have been published by various observers and computers from time to time. Some of the statements have been made in previous papers by the writer, but in a detached and less definite manner.

The swift meteors are decidedly higher in the atmosphere than the slow meteors. The luminous flights of fireballs are much longer generally than those of ordinary shooting stars. Both fireballs and shooting stars from low radiants have longer paths than those from radiants at high altitudes.

Nearly all the slow-moving fireballs are directed from radiants in the vicinity of the horizon. The great majority of fireballs travel slowly, and their radiants are placed in the western half of the sky and somewhere in the region of the earth's anti-apex.* The most numerous class of shooting stars would appear to be formed by the swift meteors directed from radiants fairly elevated in the eastern sky, but this will not be found invariably true for all seasons, there being many strong showers clustered at distances rather remote from the apex of the earth's way and yielding an abundance of shooting stars which exhibit a medium or slow rate of velocity. Theoretically the swift meteors should greatly predominate were meteor streams generally distributed in an equable manner, but this is far from being the case, and the result is that moderately slow or slow meteors are often more plentiful than any other class. It is true that our lists of real paths contain a great excess of swift meteors, but it must be remembered that the bulk of the observations has been effected during the Lyrid, Perseid, Orionid, Leonid and Geminid epochs, when such meteors are exceedingly frequent, though most of them have their origin in the special systems referred to and do not prove a general prevalence of rapidly moving objects.

A singularly well-marked height at which slow-moving fireballs disappear is 26-29 miles. Comparatively few large or small meteors become extinct when between 31 and 42 miles above the earth. Nearly all the well-observed meteors have vanished either between elevations of 20-30 or 45-60 miles. Fireballs are more frequent within two hours or so after sunset than at any other time of the night; in fact the number of these bodies which make their apparitions in the evening twilight is quite remarkable. They are also often noticed in the morning not long before sunrise. This notable frequency cannot be explained on the supposition that more people being about at the hours stated than at other periods near the middle of the night there would naturally be more records of these objects. Regular meteoric observers do not witness many fireballs of the larger kind because such bodies commonly make their appearance at times either before or after the usual hours when meteor watches are conducted, and indeed they often present themselves when least expected and in conditions of sky not well suited for their observation.

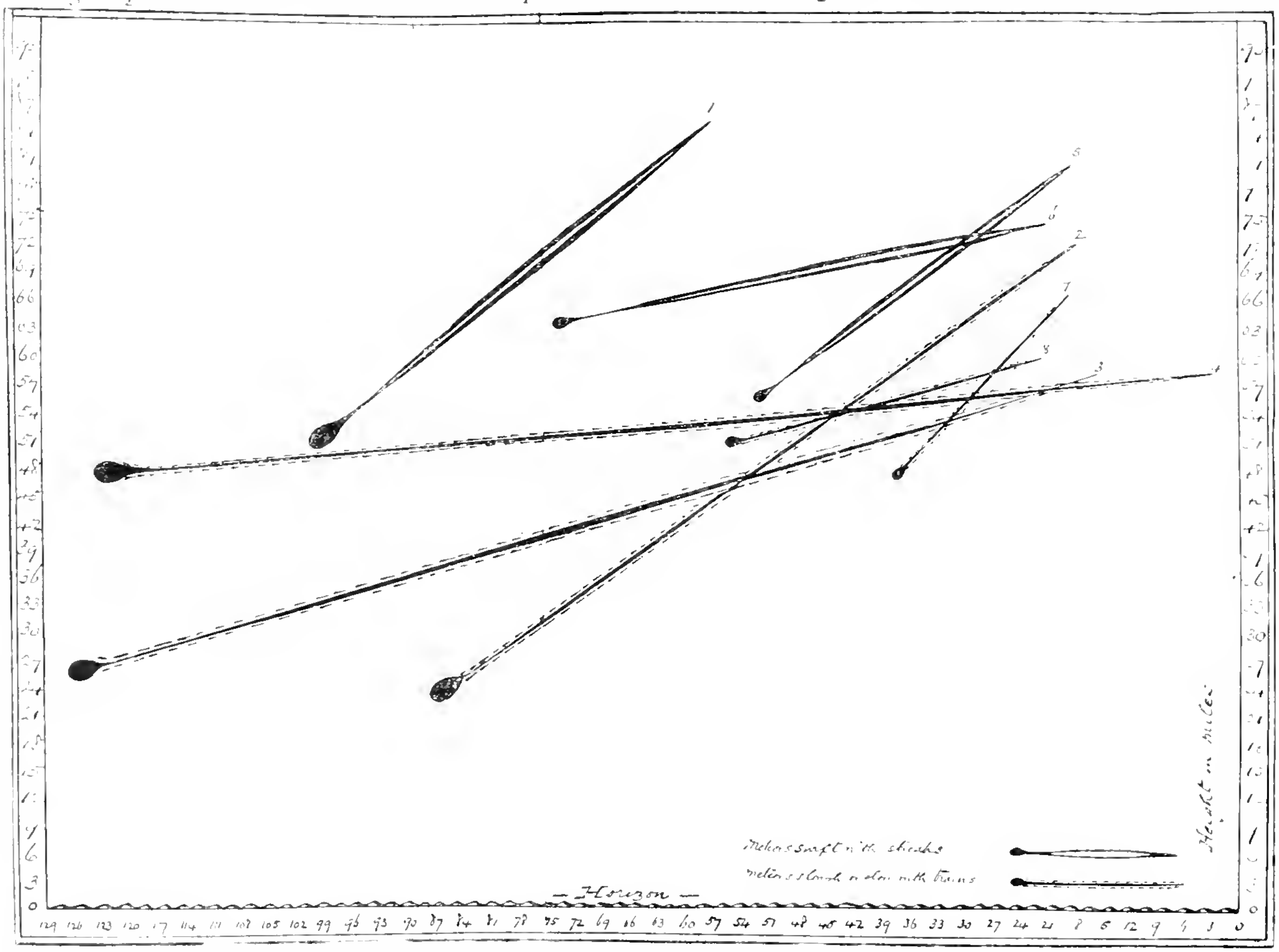
The zodiacal constellations are very rich in prominent fireball radiants. (*Monthly Notices*, Vol. LVII., p. 561.) For instance, there are well-defined showers from Pisces (Aug.-Sep.), Aries (Oct.-Nov.), Taurus (Nov.), Gemini (Dec.), Cancer (Jan.-Feb.), Leo (Feb.-Mar.), Libra (April), Scorpio (June-July), Sagittarius (June), Capricornus (July-Aug.), and Aquarius (July-Aug.). The slow-moving fireballs from radiants in the west would seem to be usually isolated and to be unaccompanied by any smaller meteors forming a definite shower-radiant. They

* *Monthly Notices*, Vol. LIV., p. 538.

overtake the earth in her orbit and move in direct orbits like the comets of short period.

The observed motion of certain fireballs and shooting stars is slower than that computed from parabolic velocity. Thus a meteor belonging to the May Aquarids seen on 1900, May 3, traversed a long and nearly horizontal flight of about 155 miles at a velocity of 28 miles per second, while the theoretical speed was 40 miles per second. Atmospheric resistance must undoubtedly induce a retardation in the velocity, and particularly in those cases where the objects penetrate to low altitudes and encounter the denser air strata. But the observed velocity has been occasionally found less than half that which would be shown by bodies moving in parabolic orbits, and some other explanation seems necessary. There are certainly marked differences, both in the apparent and real velocity of meteors from a common radiant. On 1901, Aug. 10, 10h. 58m., a very slow shooting star was observed at Slough, Farnborough, and Bristol, with a velocity of about 16 miles per second and a radiant at 352° — 11°.† On Aug. 18, 13h. 24m., a shooting star was seen at Slough and Bristol with a velocity of 15 miles per second and a radiant at 106° + 52°.† In these cases the rate of motion was carefully estimated, and the several values were very consistent with each other, but the speed only amounted to about half that which would have been exhibited by unchecked objects moving in parabolic orbits. Of about five meteors registered during the Perseid epoch from the Lyncid shower at 106° + 52°, four were of the swift, streak-leaving class, while the one mentioned above as apparently directed from the same radiant was "very slow" and offered a great distinction to the others.

The abnormally slow motion found in the two cases named cannot be wholly attributed to atmospheric resistance, for other meteors coming from the same radiants exhibited no signs of similar retardation. When comparing observations of fireballs and deducing their real heights I have been much struck at the frequency with which the disappearance occurs at an elevation of about 27 or 28 miles. It is comparatively seldom, according to my experience, to meet with a really well-observed fireball or meteor which disappeared between heights of 31 and 42 miles. From the computations made here of 96 fireballs I get the following figures:—



Height at disappearance.	Number of Fireballs.	Percentage.
Less than 12 miles	1	1·0
12 to 21 miles	19	19·8
22 to 31 ,,	30	31·3
32 to 41 ,,	12	12·5
42 to 51 ,,	19	19·8
52 to 61 ,,	9	9·4
Exceeding 61 miles	6	6·2

Combining this table with some similar and extensive

† The real paths of these objects were independently computed by Prof. Herschel at Slough, by Lieut.-Col. Tupman at Harrow, and by the writer at Bristol, and the resulting velocities were in excellent agreement. Lieut.-Col. Tupman has also determined the orbital elements, and finds a periodic time of only 224 days for the Aquarid of August 10, and of 327 days for the Lyncid of August 18, on the assumption that at the great height of 60 or 70 miles the atmospheric resistance is a negligeable quantity.

results obtained by Prof A S Herschel and Dr. Von Niessl, including 166 additional fireballs, I get the following:—

Height at disappearance.	Number of Fireballs	Per centage
Less than 12 miles	15	5·7
12 to 21 miles	55	21·0
22 to 31 „	79	30·2
32 to 41 „	39	14·9
42 to 51 „	37	14·1
52 to 61 „	24	9·2
Exceeding 61 miles	13	5·0

Thus the independent values derived from the investigations of Prof. Herschel and Dr. Von Niessl generally corroborate those obtained at Bristol, though they do not indicate such an exceptional rarity in the disappearances between 31 and 42 miles.

Prof. Herschel's heights at disappearance seem pretty evenly distributed between 19 and 30 miles, while the same may be said of Dr. Von Niessl's from 18 to 28 miles.

With reference to the length of path, shooting stars do not often extend over 50 miles, though in rather exceptional cases, when the radiant closely borders the horizon, they may considerably exceed 100 miles; as, for example, the Aquarid of 1900, May 3, already referred to. But the luminous flights of the slow-moving fireballs are usually more than 100 miles in length, and such objects often furnish grand spectacles, remaining visible from about five to twelve seconds, exhibiting a very intermittent light, and flashing out brilliantly several times as they plough their way through the atmosphere. Dr. Von Niessl's mean length of path for many large meteors observed from the continent of Europe and America is much greater than that deduced from similar objects seen in England. Possibly the discordance may be in part explained by the fact that in this country the sphere of observation is so curtailed that the visible limits of very long-pathed meteors cannot be followed, there being no observers in the region nearly under the beginning or end points which must often be placed vertically over the sea. In other parts of Europe and in America, however, the vast expanse of country enables large meteors to be successively seen at distant stations underlying their lines of flight. Thus the fireball of 1868, Sep. 5, was computed by Dr. Von Niessl to have traversed a path of 1770 miles, from Servia to France.

It is seldom that either fireballs or shooting stars are first seen at heights exceeding 100 miles, and it appears questionable whether any have ever been observed at an elevation reaching 130 miles. Heis and Niessl give rather numerous instances where the computed heights have been over 130 miles, and I have also met with a few cases of abnormal elevation, but so far as recent investigations enable me to form a just opinion, I conclude that a meteor with any part of its real path at a height exceeding 100 miles must be regarded as a rarity. The very swift meteors begin their observed luminous careers at heights from about 90 to 75 miles, while the slow meteors commence at elevations ranging from 75 to 55 miles.

An observer, after long acquaintance with the details of these observations, and after much practice in the computation of the heights of meteors, the fall of many of which he has himself witnessed, can generally estimate the height, length of path and velocity of an object to within small limits of error, immediately after seeing it. He can often assign the radiant correctly, and, having carefully noted all the visible features of the object, he recognises it as belonging to a certain class and can thus form a very good idea as to its actual course in the air. If the meteor is an ordinary Perseid, observed at a time of night when the radiant of that shower is pretty elevated, he will be tolerably sure that the flight ranged from about 81 to 56 miles in height. If the object is a slow-moving fireball, leaving a train of yellow sparks and directed towards the eastern sky from a westerly radiant not *very* near the horizon, he will be tolerably certain that it descended from a height of about 60 to 27 miles along a path of 100 miles or more.

But meteors sometimes display vagaries capable of putting the most experienced and best judgment in fault. In fact there is probably no branch of astronomy in which more blunders are possible and in which more are actually committed than in meteoric work. Be the observer ever so practised and his knowledge of the various radiants and of the details influencing their correct determination ever so complete, he cannot attribute any meteor to its centre with absolute certainty that it is correct. Even when the case is one in which he feels an unusual amount of confidence, he is liable to find afterwards should a duplicate observation come to hand, that he has been mistaken in his judgment. Possibly an old observer could correctly assign the radiant in three cases out of four, but it is always a difficult performance, and requires not only that the direction of flight should be very accurately observed, but that all the visible features of each meteor should be attentively noted, as they often serve to indicate the pretty exact place of the radiant when the path alone leaves it open to doubt.

CONSTELLATION STUDIES.

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

XI.—THE RAM AND THE BULL.

CLOSE beneath the lower points of the greater W, noticed in our last constellation-study, that is to say, close beneath Beta Persei and Beta Trianguli, is the small but distinguished constellation of the Ram. He can also be found readily by following the stars which mark the belt of Andromeda. Proceeding from Nu Andromedæ through Mu and Beta, we find at double the distance between Nu and Beta, the extremely flat triangle which marks the Ram's head. As Aratus tells us:—

"No splendid gems his golden fleece adorn,
Two dimly glitter on his crooked horn.
If you would find him in the crowded skies,
Beneath Andromeda's bright belt he lies."

Of these three stars, the brightest, Alpha, is the furthest to the north and east; Beta, the next in brightness is next also in position; and Gamma the most southern and westerly, is the faintest. A compact little triangle about half-way from Alpha Trianguli to the Pleiades comprises practically all the other important stars of the constellation.

The mythology of the constellation is as little striking as is its actual appearance in the sky. It is, of course, associated in Greek mythology with the voyage of the Argo; it is indeed the Ram whose golden fleece the Argonauts went forth to seek. But the story carries no conviction with it, nor is there anything in the surrounding constellations to support the legend, although so great an astronomer as Sir Isaac Newton held that the stellar symbols were intended simply as a record of the Argonautic expedition.

An explanation which at first sight appears more plausible, asserts that the Ram was the constellation in which the sun was placed at the spring equinox at the time when the constellations were mapped out, and that as the first of the zodiacal twelve, it was natural to symbolize it as the bell-wether of the starry flocks. Unfortunately for this theory we know that the constellations were mapped out at a far earlier epoch when the equinox fell in the middle of the constellation Taurus.* At that date the constellation of the Ram came last of the zodiacal twelve, and to represent it as the stellar bell-wether would have been absolutely the most unnatural thought possible.

Yet from an early age it has had that position. It is the leading sign in the systems of astrology which have come down to us through the Greeks, and it figures as the leading sign in most of the explanations of the constellation figures which have come down to us from antiquity.

There is a great significance in this fact. It proves at once that these astrological systems and these theories of the constellation figures, not only took their rise at a later epoch, but that when they took their rise the real origin and meaning of the designs had been wholly lost.

The only stars in the constellation that are usually known by their Arabic names, are the three in the head. Alpha is known as Hamal, the "Ram," the brightest star being put for the entire constellation.

* Through an obvious slip, Mr. R. Brown, on page 54 of Vol. I. of "Primitive Constellations," is made to say that the stellar Ram "onwards from B.C. 2540 opened the year," instead of "from 2540 *years ago*," the time when the equinox really fell amongst the three stars of the Ram's head.

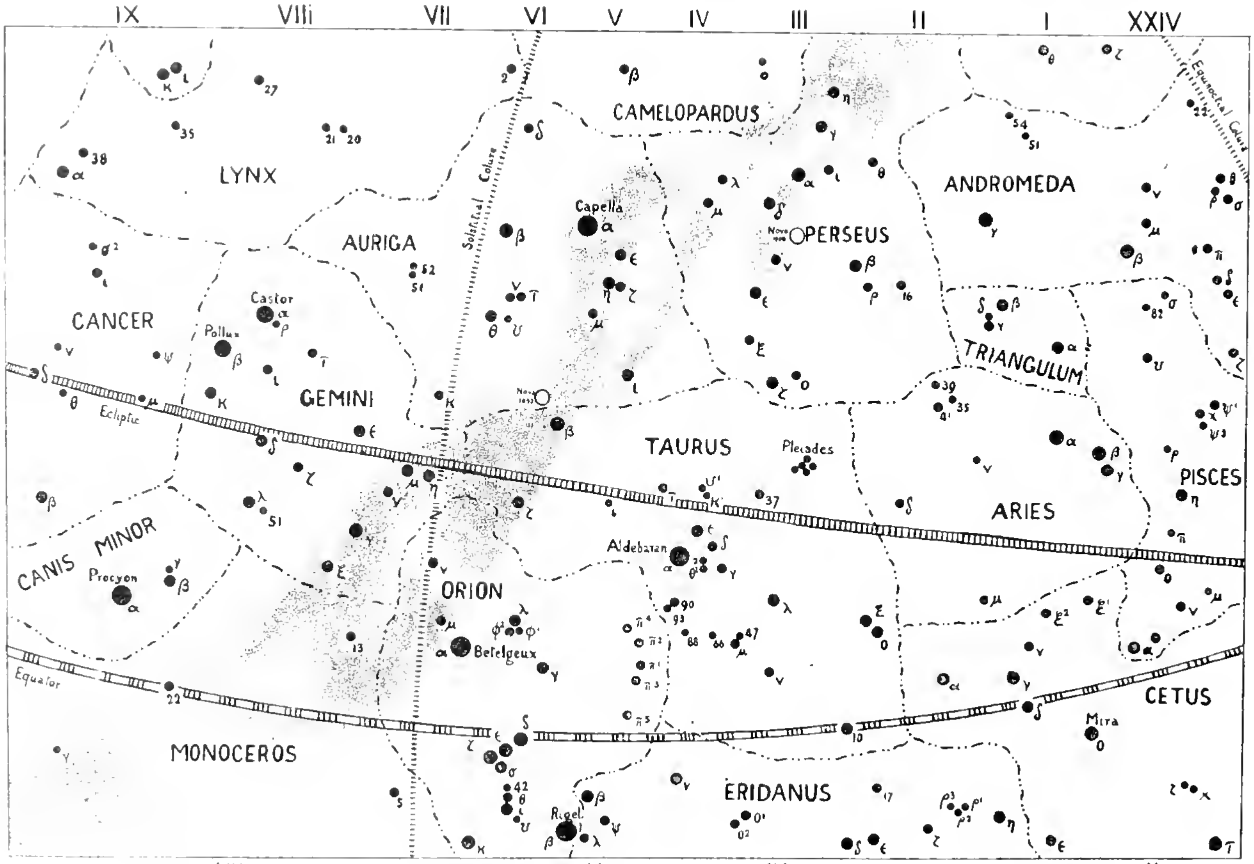
Brown indeed asserts that the stellar Ram was in the first place only the star Hamal, the constellation being formed round it afterwards. In Chaucer the star is referred to as Alnath, that is to say, "the horn-push," a name more commonly associated nowadays with the star on the tip of the northern horn of the Bull, Beta Tauri, to which it is even more appropriate.

> "And by his eighte speres in his working,
> He knew full well how far Alnath was shove
> Fro the head of thilke fix Aries above,
> That in the ninthe spere considered is."

Since the actual stars were accounted to be placed in the eighth sphere whilst the twelve equal signs of the zodiac, each of thirty degrees of longitude, were placed in the ninth, Chaucer is here stating that his astrologer knew the distance from the first point of Aries, that is to say from celestial longitude 0°, to the first star in the actual constellation Aries. In other words, he knew the amount of precession.

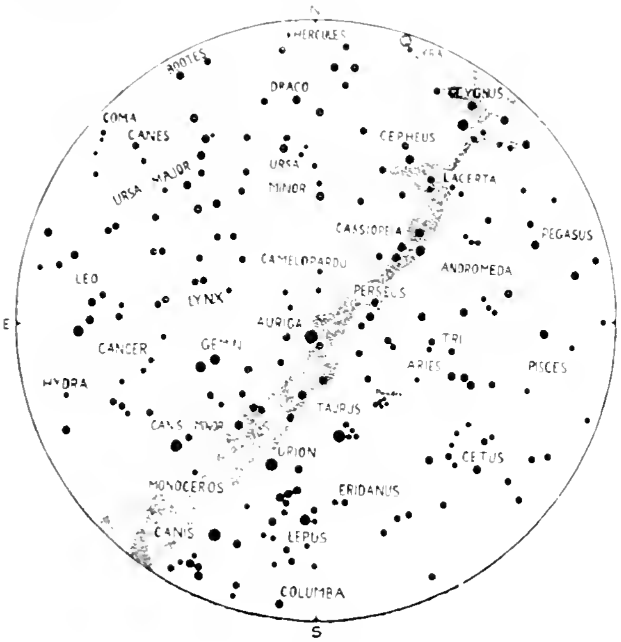
Beta and Gamma bear the names Sheratan and Mesartin, the former word meaning "the two signs," the latter "the two attendants," the two names taken together therefore meaning "the two attendant signs," these two stars being considered as attendants on Hamal.

A far brighter as well as larger constellation is that of the Bull, the original leader of the zodiacal twelve. There is no difficulty at all in finding its principal stars. The Pleiades, to the naked eye by far the most striking star cluster in the heavens, mark the shoulder of the Bull; the Hyades, a looser, but yet brighter group, mark its head. The latter group forms an exceedingly well-marked capital V. Aldebaran, Alpha Tauri, a bright



Star Map No. 11; The Region of the Ram and the Bull.

orange star, marks the upper left hand of the V. Epsilon Tauri similarly marks the point on the right, whilst Gamma marks the angle. Theta 1 and Theta 2 lie between Alpha and Gamma, and three stars marked Delta lie between Gamma and Epsilon. Following the two branches of the V eastward to about four times their length, we come to Beta and Zeta, which mark the tips of the two horns, Beta, the northern horn, being much the brighter of the two. These are the chief stars in the constellation, for the Bull, like Pegasus, is shown only in half length, and beside his head and horns possesses little but the fore-legs. Iota Tauri stands just mid-way between Beta and Zeta on the one side, and Alpha and Epsilon on the other. A straight line from Iota through Gamma leads to Lambda Tauri, and followed on, passes just below Omicron Tauri, which forms a pair with Xi Tauri.



The Midnight Sky for London, 1901, December 3.

The names in the constellation in familiar use to-day are restricted to the names for the two groups, the Pleiades and the Hyades, to the classical names for the individual stars in the former group, and to the two stars Alpha and Beta. Beta, as already noted, is Alnath, "the horn-push"; Alpha is Aldebaran, "the follower," that is to say, of the Pleiades:

"Near Perseus' knee, the Pleiads next are rolled
Like seven pure brilliants set in ring of gold;
Though each one small, their splendour all combine
To form one gem, and gloriously they shine.
Their number seven, though some men fondly say
And poets feign that one has passed away.
Alcyone—Celeno—Merope—
Electra—Taygeta—and Sterope—
With Maia,—honoured sisterhood by Jove
To rule the seasons placed in heaven above.
Men mark them rising with the solar ray
The harbinger of summer's brighter day;
Men mark them rising with Sol's setting light
Forerunners of the winter's gloomy night.
They guide the ploughman to the mellow land;
The sower casts his seed at their command."

Of all the star groups none figures so largely in myth and legend and literature as the Pleiades. The name Pleiades is probably derived from the Greek Pleiones "many," and accords with the Hebrew Kimah, "the cluster," the Babylonian Kimtu, "the family," and the Arabic Ath-thurayya, "the little ones." The name given to the individual stars are those of the seven daughters of Atlas and Pleione. According to Aeschylus they were placed in heaven on account of their filial sorrow when their father was turned into the mountain and laden with the weight of the firmament. Of the numerous other names which have been given them, the "Hen and Chickens" is one of the most familiar. Thus Miles Coverdale in a marginal note to the book of Job in his translation of the Bible, calls them "the Clock Henne with her chickens." Many of the Greek poets refer to them as "the doves" or "rock pigeons," writing their name as "Peleiades." They were likewise the "Vergiliae," "the stars of spring," or the "Atlantides," from their father. Modern astronomers have commemorated Atlas and Pleione, the parents of the seven, in the pair of stars on the east of the group.

Their value to the ancients as an indication of the seasons and the progress of the year was immense. As noted in Dr. Lamb's unduly expanded paraphrase from Aratus quoted above, their heliacal rising showed the commencement of summer, their acronical rising the commencement of winter. Four thousand years ago they marked the position of the sun at the spring equinox, and were therefore then especially closely connected with the revival of the forces of nature in the opening year. This no doubt is the first meaning of the reference to "the sweet influence of the Pleiades" in Job xxxviii. Whilst in conjunction with the sun they were hidden from view for forty days, reappearing as summer drew near. Thus Hesiod sings:

"There is a time when forty days they lie
And forty nights concealed from human eye;
But in the course of the revolving year
When the swain sharps the scythe, again appear."

In November, on the other hand, they are up all night and are on the meridian at midnight. In some mysterious way they became associated with the memorial observances for the dead which in so many nations have always been associated with this month of November, and which seem to point to the great Christian commemoration of All Saints' Day.

A keen sight will count nine or ten stars in the group. Moestlin, according to his pupil Kepler, counted fourteen. Miss Christabel Airy plotted twelve; but these high numbers are hardly obtained legitimately, inasmuch as they include stars lying at some considerable distance from the main portion of the group. Six stars are easily seen, and amongst nations the most widely scattered and unconnected, we find the tradition that though six stars are only visible to-day, seven was their original number. The probability seems that this is no mere legend, but the record of an astronomical fact. Several of the present Pleiads are slightly variable, and Alcyone, the leader in brightness to-day, would seem to have only attained that rank within the last few centuries. It is therefore quite conceivable that one of the members of the group, now too faint to be detected without a telescope, may in time past have fully rivalled her sisters.

Even such small magnifying power as an opera-glass can lend greatly increases the beauty and interest of both the Pleiades and the Hyades, and the whole region between the Bull's horns. Close to Zeta Tauri, the southern horn tip, is the Crab nebula, the first in Messier's catalogue, and from its comet-like appearance, a snare to beginners in the art of comet seeking. Zeta Tauri marks very nearly the radiant point of a shower of very slow and bright meteors active at the end of

November and early in December; whilst Epsilon Tauri is not far from the radiant point of the other great Taurid stream, active from October 20 to the end of November.

Lambda Tauri is a variable star of the same class as Algol, Beta Persei; that is to say, its variation is due to the transit across it of a dark companion. Its period is 1h. 12m. short of four days; its maximum, or rather ordinary light, ranks it of magnitude 3.4, at minimum it sinks down to 4.2.

"Next the broad back and sinewy limbs appear
Of famed Auriga, dauntless charioteer,
Far in the north his giant form begins
Reaching athwart the sky the distant Twins,
The sacred goat upon his shoulder rests,
To infant Jove she gave a mother's breasts.
Kind foster nurse! Grateful he placed her here,
And bade her kids their mother's honour share.

* * * * * * *

Auriga and the Bull together meet,
Touches his star-tipped horn the hero's feet.
The Bull before him to the west descends
Together with him from the east ascends."

Beta Tauri, the northern horn, belongs also traditionally to the constellation of Auriga; now known as "the charioteer," although no chariot is visible, and in Ptolemy's star list as well as in our modern representations he is described as in the attitude of a shepherd, carrying a goat on his shoulder and a pair of little kids in his hand. The Greek name for the constellation is Heniochus, "the holder of the reins"; a name preserved for us in the Arabic name for Beta Aurigae, "Menkalinan," "the shoulder of the reinholder."

The chief stars of the constellation are easily picked out. Capella, a bright star of a yellowish creamy light, nearly balances the steel-blue gem Vega on the opposite side of the pole star. Close to Capella, three small stars in a long right-angled triangle, form an unmistakable mark of identification to it. Glancing back to Sirius, Procyon, Castor and Pollux, we find that they form a magnificent curve, which, carried onwards, passes through Beta Aurigae, and ends in Capella. Taking Beta as the head star of a cross, Capella marks the western extremity of the crossbeam, Theta the eastern, and Iota the foot. A straight line from Theta upwards through Beta leads to Delta, a star which marks the head of the figure. Of the three stars marking the little triangle by Capella, Epsilon is the nearest to Capella, and Eta and Theta, known as the Haedi, "the kids," mark the short side of the triangle.

In recent years the constellation has been most distinguished by the appearance of the new star discovered on February 1, 1892, by Dr. T. D. Anderson, using only a small pocket telescope. The position of the Nova is in the extreme south of the constellation, about 3° to the north of Beta Tauri. At the time of discovery it was about the 5th magnitude, and slightly brighter than Chi Aurigae, which is just 2° to the north of it.

Letters.

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

BRILLIANT METEOR IN CALIFORNIA.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—On August 17th, at 7.55, a very brilliant meteor passed over this district and was observed by a great many people. It was seen all along the Pacific coast from San Diego to Los Angeles, and from places thirty or forty miles east of the coast. Unfortunately I only saw the flash, through the open doorway, every tree and the houses, etc., were most brilliantly lighted up, as if a most powerful searchlight had been swung across them. I have received a great many descriptions of the meteor from eye witnesses, some of them very conflicting, as nearly everyone saw it burst in a different place; some heard the report of the explosion and felt the earth tremble, while others heard no noise, but all agreed in describing it as very large and leaving a brilliant train. From all the evidence I think the following is the best and most accurate:—The direction was from the zenith to a point a little east of Polaris, the head was very large, perhaps half the diameter of the moon, and pear shaped; there were numerous explosions along its path, leaving many brilliant fragments, and a final explosion when it disappeared, which was distinctly heard by several people on the mountains, who said the earth trembled as it would with a slight earthquake.

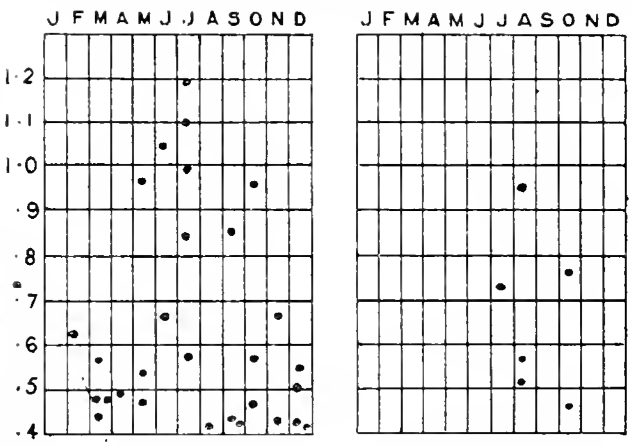
I observed nineteen of the Perseid meteors on August 11th between 8 and 10, high fog prevented observation on the other evenings. S. D. Proctor.

Encinitas, California, U.S.A.
Sept. 3rd, 1901.

DOES THE MOON AFFECT RAINFALL?

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Recent Greenwich records apparently point to a maximum of wetness about the time of new moon, and a minimum shortly before last quarter. To appreciate the nature of this contrast, let us take the last twelve years (1889-1900), and confining our attention to the three days about new moon, on the one hand, and three days before last quarter on the other, ask how often, in these three-day groups, there occurred a rainfall of ·4 in. or more in one day, and how these cases were distributed. The answer is supplied by the rough diagram herewith, in which each dot represents a wet day of the magnitude indicated. There are 29 cases in the three days about new moon, and only 6 in the three days before last quarter (about one-fifth of the



Three days about New Moon. Three days before Last Quarter.

other). While these wet days have occurred in every month but January in the one case, they are confined in the other to the three months—July, August, and October. It may be interesting to observe whether such a contrast is maintained in future. At present I have not the opportunity of extending the above inquiry beyond the last twelve years, but perhaps some of your readers may be inclined to do so.

Alex. B. MacDowall.

NOTES.

ASTRONOMICAL.—Prof. Campbell has recently published further details of the system of Capella, which was recognised as a spectroscopic binary by Mr. Newall and himself independently. (Lick Obs. Bull., No. 6.) The principal star has a spectrum of the solar type, and its velocity ranges from +4·2 to +55·7 km. per second, while the companion has a spectrum between the solar and Sirian types and a velocity in the line of sight ranging from −3 to +63 km. per second. The masses of the two components are therefore as 1.26 to 1, but for various reasons, the masses in terms of the sun are as yet indeterminate. The orbit is nearly circular, the period 104 days, and the whole system is receding from the sun at the rate of 25·76 kilometres per second. As the inclination of the orbit cannot be determined with the spectroscope, the actual size of the system remains unknown, but with the smallest permissible orbit, the two stars will be 85,000,000 kilometres apart when most distant from each other. So far, even under the most favourable conditions, the Lick telescope has failed to show any indications of the binary character of the star. The latest investigations of the spectroscopic binary η Pegasi indicate for this star a period of 818 days (Bulletin No. 5).

As was to be expected, a very valuable set of observations of Nova Persei has been secured at the Lick Observatory (Bulletin No. 8). The position of the star has been carefully determined by meridian observations and by micrometric measures, and a long series of estimates of magnitude have been recorded. Extensive spectroscopic observations have also been made, and the high dispersion employed has revealed much minute detail which may perhaps turn out to be of great importance. Among the more important results, it appears to have been established that the velocity of the Nova, as indicated by the fine dark line superposed upon bright H has been practically constant and very small, up to September. At present the spectrum is nebular, an additional demonstration of this being furnished by the discovery that the Nova line near H, occurs as a line at λ3967·6 in N.G.C. 7027, and that the strong ultra-violet line about λ364 also appears in some of the well-known nebulæ. It is the last named radiation which probably causes the spurious aureole surrounding the photographic image of the Nova as depicted by a refractor.

From the Lick Observatory comes the startling announcement that four nuclei in the true nebula in which Nova Persei is involved have been displaced by a minute of arc in six weeks.

One of the most remarkable stars in the heavens is η Argûs, which between 1677 and 1870 fluctuated between magnitude 0 and 6·8 and has since faded to $7\frac{1}{4}$. It has long been known that the spectrum was an uncommon one, and recent photographs taken by Sir David Gill show that it is full of bright lines which are apparently similar to those of Nova Aurigæ and Nova Persei in their earlier stages. Dr. F. McClean has already drawn attention to the fact that the spectrum is practically a reversal of the spectrum of α Cygni.—A. F.

BOTANICAL.—The well-known fairy rings met with on our lawns and pastures are produced by various species of Fungi, most frequently by *Marasmius oreades*. In North America it has been observed that similar peculiarities of growth are effected by other plants besides Fungi. In *R*[illegible] Dr. Robinson cites the case of one of the club mosses (*[illegible]*). He attributes the rings to the plants moving outwards from the centre in search of fresh soil and new food supplies. Mr. W. N. Clute in the October number of the *Fern Bulletin* records instances of rings formed by species of *Osmunda*, and conjectures that these rings have taken at least a hundred years in their formation. *Monarda didyma*, a Labiate often seen in British gardens, is also, according to Professor Beal, a producer of fairy rings.

The origin of the eminently useful cocoanut palm, like that of several other valuable economic plants which have been in cultivation for very long periods, is still disputable. De Candolle, in his *Origin of cultivated plants*, expressed the opinion that, though he formerly thought that the arguments in favour of Western America were the strongest, a more extended study of the subject inclined him to the idea of its origin being in the Indian Archipelago, a view which received the support of many celebrated naturalists. Mr. O. F. Cook has been dealing with the question in the recently issued number of the *Contributions from the U.S. National Herbarium*, and arrives at the conclusion that the original habitat of the palm is to be sought in South America, the probabilities favouring the alkaline regions of the Colombian Andes. It is pointed out as a forcible argument that all the other known species of *Cocos* are natives of South America, and no other genus of palms is common to America and Asia or Polynesia.—S. A. S.

ENTOMOLOGICAL.—Both on account of the interest of their habits and of their importance from an economic standpoint, the gall-midges (*Cecidomyidæ*) are worthy of more attention than they usually receive from naturalists. Their small size makes their study very difficult. Specially acceptable therefore is the recent issue of the Abbé J. J. Kieffer's "Monographie des Cécidomyides d'Europe et d'Algérie" in the *Ann. Ent. Soc. France*, Vol. LXIX., 1900, pp. 181-472, pls. 15-44. This work includes a very full bibliography, a detailed account of the anatomy of the midges and their larvæ, a summary of the very various ways in which the latter feed in different plant tissues, each causing its characteristic gall, and a systematic account of the genera into which the family has been divided. The species of economic importance—the dreaded "Hessian-fly" of wheat and the "Pear-Midge" are well-known examples—are dealt upon at length, and the natural and artificial means of checking their ravages are pointed out. Among our helpers in the destruction of these injurious insects are to be reckoned birds, spiders, insects (chiefly parasitic Hymenoptera) and minute thread-worms, which live inside the Cecidomyids in both larval and perfect stages.

From notices in the various entomological journals, the year 1901 seems to have been remarkable for the great abundance of Hawk-moths in the British Isles. Records of the Death's-head (*Acherontia atropos*) and of the Convolvulus Hawk-moth (*Protoparce convolvuli*) have been plentiful, and the latter insect seems to have bred freely with us, as caterpillars have occurred in Scotland and Ireland as well as in England. The green form of the caterpillar—a marked contrast to the brown type—has been noted in several localities.

The scales on the wings of butterflies and moths are often considered to be purely of ornamental importance. In a recent paper "Ueber Nervenendigungen auf dem Schmetterlingsflügel" (*Zoolog. Jahrb. Abth. f. Anat.*, XIV., 1901, pp. 551-572, pl. 42), Dr. K. Günther points out that they must have to some extent a sensory function, as their roots are sometimes in contact with processes emanating from special cells of the hypodermis into which fine nerve-endings pass.—G. H. C.

Zoological.—In the *Geological Magazine* for October Mr. C. W. Andrews continues his preliminary description of the wonderful new Eocene vertebrate fauna recently brought to light in the Fayum district of Egypt; this part being chiefly devoted to the reptiles. Perhaps the most remarkable of these is a large freshwater tortoise belonging to the "pleurodiran" division, or those in which the head and neck are moved sideways; this group being now restricted to the southern hemisphere, although it was formerly spread over much of Europe and Asia. The most remarkable feature about the new form (for which the name *Stereogenys cromeri* is proposed) is connected with the palate, which has a structure recalling that of modern crocodiles, the palatal aperture of the nostrils being placed quite far back. The collection is also noteworthy on account of containing remains of the largest snake hitherto known, which the author calls *Gigantophis garstini*. If the vertebræ of this monster bear the same proportion to its length as obtains in the case of modern pythons (to which it is allied), it could not have been much, if at all, short of thirty feet. Another new generic type of serpent (*Moeriophis schweinfurthi*) appears more nearly relative to *Palaeophis* of the European Eocene. We await with interest the author's opinion as to the bearing of the new discovery on current views as to the past distribution and migration of animal life in Africa.

Those of our readers interested in cephalopods will remember that years ago Professor Owen described the "animal" of the nautilus, on the evidence of a single specimen, then regarded as a great rarity. For centuries, however, it appears probable that the fishermen of certain small islands in the Philippines have been constantly in the habit of taking nautiluses, which enter their fish-traps at certain seasons of the year in considerable numbers. Hearing of this, Mr. Bashford Dean recently made a trip to Negros Island, where he was successful in obtaining several specimens; and he would have got more had his visit been timed at the right season. The traps are sunk in deep water, and the nautiluses enter with the fish. "The shells," writes Mr. Dean in the *American Naturalist* for October, "have hitherto found little market; locally, they are used as drinking cups or flower vases, and are sometimes cut into roughly-shaped spoons. But they are now bought extensively by Chinese shopkeepers, and at such good prices that there will probably be a goodly nautilus fishery before long. The Chinese, I was told, export the shells to China where they are used as material for button-making. British mother-of-pearl dealers and manufacturers ought to bestir themselves and see whether nautilus-shell is not suitable for their own purposes.

The Entomological Division of the U.S. Department of Agriculture is displaying even more than its usual vigour in describing insect pests and the remedies best calculated to stay their ravages. Three bulletins have recently been issued by the division, one dealing with the "fall army-worm" and variegated cut-worm, another describing a new beetle whose attacks are ruining the forests of red spruce in New England, and a third treating of various pests.

"Luck" sometimes attends the efforts of naturalists. Years ago the secretary of the Zoological Society described what he regarded as a new species of rhinoceros from Chittagong, chiefly upon its hairy character. Upon the death of the specimen Mr. O. Thomas decided that these characters were of no value; but that, on account of its superior size, the Chittagong rhinoceros was still entitled to distinction from the Sumatran animal, although only as a sub-species.

The addition of a new genus of living mammals to the fauna of Europe or its confines is an event of sufficient interest to be recorded in this column. The creature in question is a vole from the Caucasus, for which the name *Prometheomys schaposchnikowi* is proposed by its describer, Dr. C. Satunin, in the *Zoologische Anzeiger* for September. It is described as being of the size of a small water-vole, and chestnut-brown in colour, with lighter feet; the minute eyes are covered with skin. The teeth are nearest to those of the mole-voles, or zokors (*Ellobius*). The single example was taken under flowering anemones.

The full text of Dr. W. T. Blanford's important memoir on the distribution of vertebrate animals in India, Ceylon, and Burma, has just been published in the Philosophical Transactions of the Royal Society, illustrated by a coloured map. The leading features of Dr. Blanford's division of India into zoological provinces have been already mentioned in these columns.

Notices of Books.

"Use Inheritance: Illustrated by the Direction of Hair on the Bodies of Animals." By Walter Kidd, M.D. (A. & C. Black.) Illustrated. 2s. 6d. net.—The interest of this able little work is two-fold. In the first place the author describes and classifies the remarkable "whorls" occurring in the coat of so many mammals (especially the hoofed group), which form the starting points of changes in the direction of the hair. The second and most important object of the book is, however, to show that changes in the direction of the hair-slope of animals have been acquired by use and become inherited; a very notable instance of this being the direction of the hair-slope on the backs of a certain percentage of individuals of the human species. It is accordingly urged that, in this particular instance at any rate, the doctrine that acquired characters are never inherited does not hold good, and hence a Lamarckian explanation of the phenomena must be accepted. The case, as argued by Dr. Kidd, appears to be a strong one, and it will be curious to note what the out-and-out Weismannists will have to say in reply.

"A Text-Book of Astronomy." By Prof. G. C. Comstock. (New York and London: D. Appleton & Co. London: Hirschfeld Bros.) 7s. 6d. net.—This volume is well worthy of a place among the "Twentieth Century Text Books," and is a welcome indication of the increasing recognition of the value of astronomy as an educational subject. Personal observations, even with the simplest of home-made apparatus, are strongly recommended, and throughout the book the student is required to do many things besides merely reading the text. In those branches of the subject which do not provide suitable practical exercises, the author has given brief but clear and well balanced accounts which can hardly fail to attract the beginner, and lead him to search for more in works of a less general character. The numerous illustrations are well chosen and admirably reproduced, and they will well repay the careful study which is advised by the author; fig. 55 very clearly represents the moon's path with respect to the sun, and the variation in the number and latitudes of sun spots is illustrated in a very striking manner in fig. 82. We confidently recommend the book to those who may require a sound introductory work on astronomy, and we think also that those who may be already familiar with the subject will find the author's methods of considerable interest.

"Irish Topographical Botany." By Robert Lloyd Praeger. (Dublin Academy House.) With 6 maps. 10s. 6d.—The appearance of such works as the second edition of "Cybele Hibernica" and the volume before us within a period of four years implies considerable recent activity on the part of Irish botanists. This is confirmed by a perusal of the long list of papers which have been used by the author in the compilation of this volume, a large proportion of which have appeared during the last decade. From the point of view of plant distribution, Ireland, by reason of its geographical position, geological structure and climatal conditions presents peculiar features of interest. It had, moreover, fallen somewhat behind the sister island in the study of its topographical botany, and the present advance was, therefore, highly desirable. The author, already well known by his numerous contributions to Irish botanical literature, has done yeoman service in bringing together the results of his own observations and those of other workers, in a form which will be of immense value to local botanists as well as to those who require materials for a study of plant distribution on a larger scale.

For the purposes of this work Ireland is partitioned into 40 botanical divisions, corresponding for the most part with the counties, the six largest of which are further divided into 14 parts. The boundaries of the divisions, chosen with a view to their easy recognition in the field, are, therefore, not as a rule natural, and the scientific significance of the records is in consequence somewhat disguised. On the other hand, the areas are thus made comparable in size with those adopted by Watson for Great Britain, which is a point of some importance. The author makes a new departure from the established custom of similar works in the use of the latest records of localities in preference to those of the first discoverers. This, we think, is entirely commendable, as the object of the work is to give an account of the present-day condition of the flora rather than to perpetuate the memories of pioneers. At the same time, by comparing the late with the earlier records it would have been possible to draw up a list of plants which in the course of climatal, cultural, and other changes, have disappeared from certain localities. Such a list would be of considerable interest, and we have sought for it in vain.

The introduction is well written and contains much interesting information. A general explanation of the significance of the different types, signs, contractions, and punctuation used in the body of the work is to be found on pages xcii.-xcix. Although these are generally uniform with those used in other works of the kind, and are therefore familiar to botanists, we think, nevertheless, that it would have been an advantage if these explanations were given in the preface or in some equally conspicuous position where they would be more easily found.

The topographical botany of Ireland, as is shown on plate 4, is still by no means thoroughly worked out. Those who carry on the research will find their labours much lightened by this gathering together of all the information at present available. The author is to be sincerely congratulated upon the production of a work which has involved no small amount of labour and personal sacrifice, and the appearance of which will be hailed with satisfaction by all interested in Irish botany.

"Dragons of the Air; an Account of Extinct Flying Reptiles." By H. G. Seeley. (Methuen.) Illustrated. 6s.—Partly, no doubt, owing to the account of their bony structure given in Dean Buckland's well-known "Bridgewater Treatise," Pterodactyles, in common with Ichthyosaurs and Plesiosaurs, are more familiar, at least by name, to non-scientific readers than are many other groups of extinct creatures. And this circumstance, together with the remarkable organisation of these reptiles, may be taken to justify the devotion of a work written on somewhat popular lines to their description and history. By no one have the "Flying Dragons" (as they ought to be called, were not the name usurped by an existing lizard) been studied with more care and attention than by Professor Seeley, who has devoted some of the best years of his life to the investigation of their structure and relationships. In this respect the author is probably better qualified than anybody else to tell the public all that is known concerning these strange reptiles. But there is such a thing as an *embarras des richesses*, and the learned professor's store of information with regard to pterodactyles is so great, while his views as to their affinities are so complex, that he has found it difficult to express himself with that simplicity so desirable in all popular works, and it is consequently a matter of some difficulty to ascertain the real nature of his views and opinions.

Unlike both birds and bats, pterodactyles flew by means of a membrane supported by the enormously elongated bones of the "little finger." And this essential difference in structure has induced the belief among the great majority of anatomists that, in spite of numerous resemblances, there is no near affinity between these reptiles and birds. This, however, is by no means the opinion of the author of the volume before us, who insists that there is some intimate relationship between the two; although the precise nature of this is left in great obscurity. Neither are the restorations of the bodily form of the "Dragons of the Air" commonly seen in palæontological works accepted by the author, who in this respect has struck out a line entirely his own, with the result that the creatures, as depicted by his artist, offer excellent examples of the "scientific use of the imagination." Whether they were capable of moving about in this posture is a question of which we may be permitted to have our doubts.

With every inclination to regard originality of view as of high value, we must confess to a feeling of disappointment with this work, if only for the reason that we cannot understand a large portion.

"Zoology: an Elementary Text-Book." (Cambridge Natural Science Manuals.) By A. E. Shipley and E. W. MacBride. (Cambridge University Press.) Illustrated. 10s. 6d. net.—If we may judge by the number of manuals and text-books in course of issue for their benefit, the number of students of zoology must be increasing by "leaps and bounds," otherwise it would apparently be a bad look-out for the publishers. We have, for instance, now in course of issue the "Cambridge Natural History" (a volume of which was noticed in our last issue), Professor Ray Lankester's "Treatise on Zoology," and the present series—all admirable in their way.

Unlike the "Cambridge Natural History," in which the two are treated together, the present series devotes separate volumes to extinct as distinguished from living types; the fossil vertebrates having been already described in a companion volume by Mr. A. Smith Woodward. In our own opinion the former method is decidedly preferable; but this is merely a matter of opinion, and on the lines which the editor has thought fit to adopt the present volume is in the main excellent.

Even with a dual authorship, it is no light task to write an up-to-date manual of zoology within the compass of an ordinary octavo volume, and the authors of the one before us are to be congratulated on the general success of their efforts.

As stated in the preface, the treatment is by no means equal throughout, the lower types, which come first in the volume, being described in a more elementary manner than those which follow. The reason of this is obvious. The reader is presumed to have no previous acquaintance with zoology, and he is accordingly introduced to his subject absolutely *de novo*. When he has proceeded some way in the book he is supposed to have assimilated the information contained in the earlier chapters, and his instruction accordingly proceeds by comparison with what he has learnt.

Great prominence is given to the doctrine of the "cœlom"; the majority of animal groups being classified as Cœlomata or otherwise. We must, however, find fault with the arrangement of the table of contents, in which no clue is given to the fact that the last four "phyla" do not belong to the Cœlomata. In respect of these last four groups the classification is a novelty so far as English text-books are concerned. Apart from the Protozoa, Cœlenterata, and Porifera, which come first in the series, the authors trace a gradual ascent from the worms to man; all these forms exhibiting more or less clearly, in one stage or other, the presence of the cœlom. When, however, the flat worms (Platyhelminthes) are reached, the authors state that they come to four groups in which the presence of the cœlom cannot be definitely determined; and we accordingly find the Platyhelminthes, Nemertinea, Rotifera, and Nematoda placed, so to speak, above man. Although the arrangement appears peculiar, we are by no means prepared to say that it may not be defensible.

Having said that it is difficult for even two authors to write a comprehensive zoological treatise, we do not intend to presume that a single reviewer can criticize the whole. Our few critical remarks will, therefore, apply to one section. As regards birds, we notice that the authors refuse to regard the Tinamous as Ratitæ. In the paragraphs on Marsupial Mammals we think the work is scarcely up-to-date as regards the dentition and the origin of the group from an arboreal type. And there are many points of detail in regard to the treatment of the mammalia generally which afford opportunity for criticism. For instance, the statement that the ancestors of the Llamas originated in the Old World is opposed to American palæontological evidence; while a visit to the Natural Museum would serve to show that the statement as to the Giraffe being "confined to the grassy plains of the interior of Africa" is scarcely consonant with the real facts. Exception might also be taken to the statement that a *mastodon* is a *large* elephant, and still more so that its teeth are always tuberculate instead of ridged. Moreover, like many morphological writers, the authors are not sound on the subject of nomenclature, otherwise they would not retain, albeit in a half-hearted kind of way, the title *Hyrax* for the dassies.

These and other blemishes of a like nature, although unfortunate, do not, however, in any way detract from the value of the work, which may shortly be described as excellently adapted to supply the needs of the class of readers for whom it is intended.

"A TREATISE ON ZOOLOGY; PART IV. THE PLATYHELMIA, MESOZOA, AND NEMERTINI." By W. B. Benham. (A. & C. Black.) Illustrated. 15s. net.—Contrasted with the work just noticed, the volume before us presents a striking instance of the diversity of view still prevalent among zoologists on many points. In the first place the name Platyhelmia is adopted instead of Platyhelminthes for the Flat-worms, and both this group and the Nemertines are definitely included in the Cœlomata (or Cœlomocœla, as the editor prefers to call this large assemblage), whereas, as we have seen, the authors of the foregoing work state that there is no justification for such inclusion. Nor does the want of agreement stop here, the Rotifera in the present work being far removed from the neighbourhood of the Flat-worms and Nemertines. As it is not our purpose to discuss which of the two views has the greater probability of right on its side, it will suffice to call attention to the existence of such diversity of opinion.

In the present volume the subject is treated with the same accuracy and fulness of detail as is apparent in its predecessors; and the beautiful illustrations afford the student every assistance possible towards a right understanding of the text. In the author's opinion, the Planarians, together with their offshoots the Flukes and the Tape-worms, collectively constituting the Platyhelmia, are regarded as standing at or near the base of the Cœlomocœla; while the Nemertine worms form a distinct "phylum," from which it is considered probable the Annelids have originated. The ideal ancestral type is taken as the best means of illustrating the structure and affinities of the Flat-worms; whereas in the Nemertines it is considered preferable to take a "central type" as the basis of description.

The Tapeworms have a special, although unpleasant interest, on account of the marvellous nature of their transformations, and the connection of several of them with the human body. In a brief historical sketch the author states that these creatures were probably known to Moses, and were certainly familiar to Aristotle, who distinguished between ἕλμινθες πλατεῖαι, or Tapeworms attached to the walls of the intestine, and στρογγύλαι, or free Nematodes. The gradual acquisition of our knowledge of the migrations and transmutations of these organisms is then referred to, after which we have an excellent series of descriptions of the life-history of the different members of the group.

So far as we can judge, the present volume is in every way worthy of the great work of which it constitutes an important and interesting section.

"BIRD WATCHING." By Edmund Selous. (Haddon Hall Library. (Dent.) Illustrated.—In the preface to this volume the author apologises for so many shortcomings that to avoid repetition there seems little else for the reviewer to do but to praise. Nevertheless, although the subject matter of the book is extremely good and valuable, in our opinion Mr. Selous has practically thrown his opportunities away, and has produced a work written in so prolix a style that to read it is a tedious and almost annoying task. The bulk of the book is a mass of minute and undoubtedly accurate observations of the habits of birds, forming a record of almost every action of the birds watched at every hour of the day. Interspersed amongst these voluminous notes are excursions into theory and speculation which we need only say the author would have been well advised to omit. It is a great pity that the author's powers of observation, or "watching," to use the word he prefers, which have been well used, should have been lost to the public by a want of a little careful editing. Had Mr. Selous digested his note-books instead of printing them in full, and had he given us a narrative of the results of his digestion, the outcome would have been, we feel sure, both pleasing and profitable.

As it is we can only recommend the volume to ornithologists as a somewhat clumsy book of reference, but ornithologists should certainly possess it, since first hand information is always of value however presented. We had no wish to further criticise Mr. Selous, but we cannot refrain from an expression of regret at his ignorant sneer at collectors, to whom if he reflected but for a moment he would realise that every naturalist owes much.

Mr. Smit has illustrated the book very nicely, but why so good a bird-artist should perpetuate with his pencil in a book of facts such an ancient fable as that of the stork transporting small birds over the sea passes comprehension. Mr. Smit has drawn the stork with its wings raised, and five thrushes comfortably sitting in the hollow of its back. How would the artist have the trick performed when the stork's wings are making the down-stroke?

"THE EVOLUTION OF SEX." By Prof. Patrick Geddes and J. Arthur Thomson. Revised Edition. (Walter Scott.) 6s. Illustrated.—This is a revised edition of a book which appeared twelve years ago and has attracted the attention of many students of biology, both on account of its exceptional originality, and, if we may say so, because of the bearing of matters with which it deals upon the cytological work of recent years. The fundamental cause which has led to the differentiation of sex is considered by the authors to be difference of metabolism. All changes which occur in the body can be referred to the metabolism of protoplasm, and the ratio of the constructive to destructive processes is variable, the former preponderating in females and the latter in males. In most cases females are relatively more passive than males, that is, they do not spend so large a proportion of energy in active habits. Moreover, observations and experiments show that conditions favourable to constructive processes—anabolic conditions as they are called—tend to produce femaleness of offspring, while the opposite, or katabolic, conditions tend to produce males. Nutrition is thus an important factor in determining sex, but there are many other factors, such as temperature, age of parents, etc., and their influence is slowly being understood. This is a general statement of the thesis which Professors Geddes and Thomson seek to establish. As can easily be understood, the subject is a very intricate one, as well as of deep interest, because it goes to the root of the explanation of biological differences. To our thinking, however, a large part of the book is not directly connected with the evolution of sex, and a sub-title expressing the fact that the development and inheritance of the cell and of the individual might be added with advantage. A misprint occurs on p. 58, where females are said to be relatively more katabolic than males, whereas the reverse is the case.

"OUR COUNTRY'S SHELLS AND HOW TO KNOW THEM: A GUIDE TO THE BRITISH MOLLUSCA." By W. J. Gordon. 33 plates. (Simpkin.) 6s.—The first part of the title very accurately indicates the scope of the book, which will be found invaluable to those who are making collections of the shells of the native mollusca and desire to be able to classify and name them. The schemes of identification are very well arranged, and the descriptions of species supply all the necessary information. The illustrations, by A. Lambert, are excellent. The thirty-three coloured plates give representations of all the British species having shells; and the black-and-white diagrams fulfil their purpose no less satisfactorily. The style of the letterpress is bright and interesting, but the author often uses undefined technical terms which will embarrass the beginner. The glossary at the end is a necessary feature. A very scrappy account only is given of the physiology and internal anatomy of the mollusca. The book would have been materially improved by a preliminary chapter giving exact instructions for dissecting two or three common types, with simple explanations of the duties of the various organs. We are glad to notice the table of synonyms on pp. 63 and 64.

"KNOWLEDGE DIARY AND SCIENTIFIC HANDBOOK FOR 1902," the second year of issue, is now published. In the Diary portion of the work a whole page is provided for the observations of each day, while there are separate pages for monthly notes, indexing, and other objects. The following features of the handbook portion should prove especially useful to workers in astronomy:—The paths of the planets for the year illustrated with maps, astronomical phenomena of the year, monthly star maps showing the positions of the constellations and principal stars, how to use an equatorial telescope, the observation of comets and meteors, and numerous astronomical tables. Other sciences are dealt with by articles on Field Botany, by Mr. R. Lloyd Praeger, The Microscope and its Uses, by Mr. M. I. Cross, and Meteorology in Theory and Practice, by Mr. Arthur H. Bell; while there is much other useful and interesting information of a more general character. The price is three shillings.

BOOKS RECEIVED.

Anticipations of the Reaction of Mechanical and Scientific Progress upon Human Life and Thought. By H. G. Wells. (Chapman & Hall.) 7s. 6d.

Thought Power: Its Control and Culture. By Annie Besant. (Theosophical Publishing Society.) 1s. 6d. net.

Record of the Progress of the Zoological Society of London during the Nineteenth Century. (Zoological Society.)

Photography for Naturalists. By Douglas English. (Iliffe.) Illustrated. 5s. net.

Roads: Their Construction and Maintenance. By Allan Greenwell, A.M.I.C.E., F.G.S., and J. V. Elsden, B.SC., F.G.S. (*Builder* Office.) 5s.

Geometric Exercises in Paper Folding. By T. Sundara Row. (Kegan Paul, French, Trubner & Co.) Illustrated. 1s. 6d. net.

General History of Europe (350-1900). By Oliver J. Thatcher, Ph.D., and Ferdinand Schwill, Ph.D. (Murray.) 9s.

Voices of Nature and Lessons from Science. By Caroline A. Martineau. (Sunday School Association.)

Studies in Heterogenesis. By H. Charlton Bastian, M.A., M.D., F.R.S. (Williams & Norgate.) Illustrated. 7s. 6d.

Medicine. By Christabel Osborn. (Scott.) 1s.

Practical Science. By J. H. Leonard, B.Sc. (Murray.) 1s. 6d.

Treatise on Photography. By Sir William de Wiveleslie Abney, K.C.B., D.C.L., F.R.S. (Longmans.) Illustrated. 5s.

Book of the Dead. Books on Egypt and Chaldaea. By E. A. Wallis Budge, M.A. (Kegan Paul.) 3 Vols. 3s. 6d. each net.

Pitman's Shorthand and Typewriting Year Book for 1902. 1s.

Algebra. Part I. By E. M. Langley, M.A., and S. R. N. Bradley, M.A. (Murray.) 1s. 6d.

English Composition. By G. H. Thornton, M.A. Edited by John Adams, M.A., B.Sc. (Hodder & Stoughton.) 2s. 6d.

Lectures and Essays. 2 Vols. By the late William Kingdon Clifford, F.R.S. (Macmillan.) 10s.

Alcoholism: a Study in Heredity. By G. Archdall Reid, M.B., C.M., F.R.S.E. (Fisher Unwin.) 6s. net.

Last Words on Materialism and Kindred Subjects. By Prof. Ludwig Buchner, M.D. (Watts & Co.) 6s. net.

Orthochromatic and Three-colour Photography. By James Cadett and Sanger Shepherd. (Cadett & Neall, Ashtead.)

West Ham Public Libraries: Annual Report of the Chief Librarian for the Year ending 31st March, 1901. (Avenue Press, Stratford.)

Publications of the Lick Observatory of the University of California. Vol. V. 1901. (Sacramento: A. J. Johnston.)

On the Relation of Phyllotaxis to Mechanical Laws. Part I. *Construction by Orthogonal Trajectories.* By A. H. Church. (Williams & Norgate.) 3s. 6d. Illustrated.

Influence of Winds upon Climate during the Pleistocene Epoch. By Frederick William Harmer, F.G.S. (Geological Society.)

Mechanical Ventilators. By M. Walton Brown. (Newcastle: Institution of Mining Engineers.)

Biometrika. Vol. I., Part I., October, 1901. (Clay.) 10s. net.

Photography. Xmas Number, 1901. (Iliffe.) 1s. net.

Rapport Annuel sur L'Etat de L'Observatoire de Paris pour L'Année, 1900. (Paris: Imprimerie Nationale.)

Pleasures of the Telescope. By Garrett P. Serviss. (Hirschfeld Bros.) Illustrated. 6s. net.

Journal and Proceedings of the Royal Society of New South Wales. Vol. XXXIV., 1900. (Robertson & Co. Proprietary, Limited.)

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

Migrating Swallows.—We observed the last swallows, as we thought, on October 11th. None were seen after that date till suddenly on the 29th they appeared again,—swallows and house martins remaining in considerable numbers up to November 2nd. On that day they were swarming over this house, sitting in rows on the roof, or flying high in the air. Next day we saw one or two only, and not one after. Can these have been a north country lot on their way south? for I am sure our summer friends all left on the 11th October.—L. M. Sabine Pasley, Botley Hill, Botley, Hants.

[The swallows which visited Mr. Pasley were undoubtedly migrants from the north and simply broke their journey southward for a day or two in a congenial neighbourhood. Gilbert White was continually noticing that swallows visited his neighbourhood after the Selborne birds had all disappeared, and it was this reappearance of the swallows that led one of the acutest observers of nature into the mistaken idea that the birds were really hiding in a torpid state from which they awoke in occasional spells of warm weather. Facts have converted the theory of hibernation into a mere myth, and we now know very well that although the majority of swallows and martins leave this country together a great many remain some weeks longer and proceed leisurely south in small companies, stopping here and there for food and rest.—H. F. W.]

Breeding of the Blue-headed Wagtail in Sussex (*Zoologist*, October, 1901, p. 389). Mr. W. Ruskin Butterfield records that a nest of the Blue-headed Wagtail, containing four eggs, was found by Mr. George Bristow, junior, in a turnip field near Winchelsea, on May 31st, 1901. Three of the eggs were accidentally broken, but the remaining one with the nest and parent birds have been submitted to Mr. H. E. Dresser, and are proclaimed to be Blue-headed Wagtails. This bird is usually considered an irregular migrating visitor to our shores.

Broad-billed Sandpiper in Kent and in Sussex (*Zoologist*, October, 1901, p. 390). Mr. L. A. Curtis Edwards records that an immature female of this rare visitor to Great Britain was procured at Littlestone-on-Sea, Kent, on August 31st; while Mr. Ruskin Butterfield records that an immature male was shot by Mr. A. C. Wendell Price on September 14th near Bexhill, in Sussex.

Nutcracker in Yorkshire (*Ibis*, October, 1901, p. 737). Mr. W. Ruskin Butterfield writes to the *Ibis* that a Nutcracker was shot by a gamekeeper near Ilkley, Yorkshire, on January 5th, 1901. The bird proves to belong to the slender-billed Siberian form which migrated in great numbers last winter to Holland, Germany, and Scandinavia (*see* Knowledge, November, 1900, p. 256, and May, 1901, p. 115).

Tawny Owl in Ireland (*Irish Naturalist*, November, 1901, p. 230). I am glad to hear from Mr. Robert Patterson that another of the Tawny Owls unfortunately introduced into Ireland (*see* Knowledge, April, 1901, p. 90) has been shot. The sooner they are all accounted for the better.

Early Ornithologists. By the Rev. H. A. Macpherson, M.A. (*Zoologist*, October, 1901, pp. 376-383). This is an interesting article concerning four old-time ornithologists, William Turner, Pierre Belon, Conrad Gesner, and Aldrovandi, who flourished in the 16th century.

Breeding Habits of the Swift. By the Rev. Allan Ellison. (*Zoologist*, October, 1901, pp. 384-385). The author here confirms the observations made by the Rev. Jourdain (*see* Knowledge, October, 1901, p. 234), and is of opinion that Swifts regularly lay three eggs.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 10, St. Germans Place, Blackheath, Kent.*

FLOWERING PLANTS,

AS ILLUSTRATED BY BRITISH WILD-FLOWERS.

By R. Lloyd Praeger, B.A.

VI.—THE VEGETATION OF IRELAND.

When we come to investigate and endeavour to understand the distribution of plants on a large scale—to study *vegetation* in lieu of the plant associations which compose them—we find ourselves involved in a mass of facts on the one hand and of hypotheses on the other, which convey an idea of the variety of phenomena involved, and the complicated questions which at once arise. Let us take as a simple example the case of a circumscribed area of reasonable size—the island of Ireland, and endeavour to obtain some idea of its vegetation, paying a due regard to both cause and effect. Now, before we come to deal with the constitution or distribution of the flora at all, many wide questions have to be considered. Among the more important of these the following may be raised:—

1. History.—What has been the past history of the area? This involves an investigation of the evidence furnished by geology and palæontology, and by the present distribution of the fauna and flora, not only in the area under investigation, but in adjoining areas both of land and sea.

2. Position.—How does the area lie with regard to neighbouring land masses, from which the flora may in whole or part have migrated? The width and depth of intervening seas, and the set of currents and of winds are factors which must not be neglected.

3. Climate.—A thorough knowledge of the climate of the area and of all parts of it is essential—the variations of temperature, amount of sunlight, rainfall, prevailing winds, humidity of the air—all these are important factors.

4. Surface.—What is the elevation and character of the surface of the various parts of the country? What mountain-barriers are there, or what barriers formed by water? The question of river-basins deserves careful attention.

5. Soils.—The prevailing soils of the area must be noted, and this necessitates a study of the rocks from which the soils are derived. The presence or absence of lime in the soil is an especially important point.

6. Human Influence.—The flora of any civilized country has been profoundly altered by the operations of man. The state and character of agriculture must be looked into, likewise the nature of the commerce of the country, and the distribution of towns and harbours, and of lines of communication of all kinds—railways, canals, roads.

Now let us sum up very briefly the leading features of Ireland with reference to these questions. As to the past history of the country, abundant evidence shows that till a time which is, geologically speaking, quite recent, Ireland formed a portion of the western edge of the Eurasian continent. That the connection which joined Great Britain to Ireland broke down before that which joined Britain to the continent as it now exists—in other words, that Ireland became an island before Great Britain did—is also clear from the evidence. But the date of this final isolation of Ireland, and the position of the final bridge or bridges, is a much more difficult question. The extended investigations of Dr. Scharff, based on the past and present fauna of western Europe, led him to conclude that "Ireland was in later Tertiary times connected with Wales in the south, and Scotland in the north; whilst a freshwater lake occupied the present central area of the Irish Sea. The southern connexion broke down at the beginning of the Pleistocene period, the northern connexion following soon after. There is no evidence of any subsequent land-connexion between Great Britain and Ireland."* As to the difficulty of accounting for the survival of the flora throughout the Great Ice Age, if the date of the breaking down of the final connexion is pushed so far back, we need not concern ourselves at present; we are at least safe in assuming that the whole of the flora which arrived by land reached Ireland at latest at a date not long subsequent to the close of the Glacial Period. A few species may have arrived subsequently by wind or water, but a few centuries of human civilization have wrought more change in the flora than all the thousands of years following the severing of the land-connexion. As regards climate, the insular position of Ireland and the prevailing ocean winds are conducive to a mitigation of extremes of temperature, to a heavy rainfall, and to a high degree of humidity. The comparative coolness and cloudiness of the summer might be expected to preclude such plants as need a bright hot sun during the period of flowering and fruiting; while on the other hand, plants which cannot endure cold might flourish in Ireland—frost and snow are practically unknown on the west coast—while unable to endure the winter in the same latitude on the continent. Rainfall and humidity are much greater on the west coast, facing the ocean, than on the east. As regards surface, the island is generally low, over 77 per cent. of its area being of less than 500 feet elevation; the higher mountains—only a few points exceed 3000 feet—are generally grouped in isolated masses near the coast. We may expect, therefore, an essentially low-level flora, and a paucity of alpine plants. Most of the watersheds lie in the great plain which fills the centre of the island, and are of quite low elevation, so no marked difference between the floras of adjacent river-basins need be expected. As to rocks and soils, the Central Plain consists of an almost uninterrupted stretch of Carboniferous limestone, and as this is not broken up by hills, a uniformity of flora may be looked for here. Elsewhere a variety of rocks occur. The most important of these are the ancient granites and schists of Donegal, and of Mayo and Galway, the Old Red Sandstone mountain-ribs of Kerry and Cork, the granite chain of Leinster, the Silurian area of south-eastern Ulster, and the Tertiary basalt-plateau of the north-east. Thus the well-marked group of calcicole or lime-loving plants may be expected to occur chiefly in the central parts of Ireland, while calcifuge or lime-avoiding species will have their head-quarters in Ulster and generally near the margins of the island. Lastly, as to human influence. About 75 per cent. of the surface is subject to the influence of husbandry—devoted to tillage or grazing, the percentage decreasing with some rapidity from the eastern side towards the wilder western regions—so that we may expect to find the natural distribution of many plants interfered with, and many others introduced deliberately or accidentally, especially in those eastern portions, where agriculture most prevails. The railways and canals which run in many directions across the country may be expected to provide an artificial means of dispersal for both native and introduced species.

Let us now view the flora of Ireland in the light of these facts. This may be best done by examining the vegetation of certain selected areas, distinguished by physical or phytological peculiarities; these will supply the leading features which would become evident from a survey of the whole. The areas which we will select are—(1) The east coast; (2) the north-east; (3) the limestone plain; (4) the south and west coasts.

The East Coast.—The conditions prevailing here which might affect plant life are generally as follows:—England and Wales are distant only 50 to 150 miles across the Irish Sea; the rainfall is comparatively small, and the soils comparatively light and dry; limestone does not prevail; the tillage is at its maximum as regards Ireland. These conditions have a due effect on the flora. This eastern strip, from Louth to Waterford, is the head-quarters of a group of plants which in the warmer drier climate and lighter soils of

* *Proc. Royal Irish Academy* (3), Vol. III., 1894.

England have a wide distribution; such are the Flixweed (*Sisymbrium Sophia*), *Trifolium glomeratum* and *T. scabrum*, *Trigonella ornithopodioides*, *Senecio erucifolius*, and the grass *Festuca uniglumis*. The calcicole group is poorly represented; and plants of cultivation—denizens and colonists—occur in profusion. Generally speaking, the flora of this area resembles that of the adjoining portions of Great Britain, as might be expected from its position, and from the similarity of physical conditions. No doubt the plants peculiar to this eastern shore-line reached Ireland with numbers of others across the former land-connexion from England, but being less adaptable, they remained and colonized this region, while hardier species pushed westward; possibly some of them were among the latest arrivals, and found their passage westward disputed by stronger species which already occupied the ground.

THE NORTH-EAST.—The peculiarities of this area are mainly geological. In Eocene times a period of great volcanic activity resulted in the formation of bed upon bed of lava, which eventually formed a high plateau covering the greater part of Antrim and Derry, and extending far over the present North Channel. This plateau, now much reduced in extent, dislocated and weather-worn, still forms a wide area of high heathery hills, fringed with steep escarpments, and intersected with deep-carved valleys, in which the decayed lava has formed a rich soil. Climate has also influenced the flora. Phytologically and zoologically, this is the extreme north of Ireland, rather than Donegal, though the latter reaches a higher latitude. In Donegal the influence of the warm Atlantic currents is clearly felt; in the north-east both land and sea are colder. Then there is, besides, the proximity of Scotland, allowing of easy colonization in times of former land-connexion. So we should expect to find here, and we actually do find, that certain northern and characteristically Scottish plants form a marked feature of the flora, such as *Sagina subulata*, *Arenaria verna*, *Geranium sylvaticum*, *Vicia sylvatica*, *Circæa alpina*, several species of *Pyrola*, *Melampyrum sylvaticum*, *Orobanche rubra*, *Equisetum pratense*. But while Antrim possesses a larger number of plants of this type than any other portion of Ireland, it is worthy of note that most of the Scottish type plants have a wide though often discontinuous range in Ireland. With Antrim, Derry and Donegal as headquarters, they spread chiefly down the west coast, decreasing eastward, and reaching their minimum in the south-east. Physical conditions no doubt account in part for this distribution, but further reasons are needed to explain the paucity of these plants on the highlands and rough ground of, for instance, Wicklow and Waterford.

THE LIMESTONE PLAIN.—The wide stretch of low land which occupies the centre of Ireland extends from the Irish Sea at Dublin to the Atlantic Ocean at Galway, and northward and southward for fifty miles in either direction. It consists of an almost unbroken area of Carboniferous limestone; whatever newer rocks may have been at one time or another laid down on this ancient floor have been removed by denudation, so that now the deposits of the Glacial epoch, and the great turf bogs, alone cover its nakedness. In the west large areas are actually devoid of all covering, and present to the eye grey wildernesses of gnarled and fissured rock. The centre is largely occupied by huge swelling bogs, while green sinuous esker-ridges give a peculiar character to the scene; and in the east the glacial deposits are especially well developed. A number of large lakes are irregularly distributed. Though characterized by an absence of most of those species which form the leading features on the east and west coasts, the flora of this large area is tolerably homogeneous, and has a character of its own. In the first place, the great predominance of limestone has its due effect, calcicole plants forming a conspicuous feature; and the quantity of lake and marsh produces a large variety of lacustrine and paludal species. Light-soil species are few, and chiefly haunt the esker-ridges; and plants of the uplands are almost wanting. The great bogs, formed entirely of vegetable matter, are a most striking feature. These presumably arose around springs on the limestone floor, which provided a perennial supply of moisture. The patch of marsh plants around such a spring increased in size, and by its growth tended to retain the water; presently bog plants, such as Bog-mosses (*Sphagnum*), Bog-bean, Bog Asphodel, Bog Cotton, established themselves; the spring was soon buried, but fed the colony from beneath. It spread steadily. The more rapid growth of the central wetter parts caused its surface to eventually assume the form of an inverted saucer set on a flat table; the formation of a felty crust allowed of the growth of Ling, Crow-berry, and other heath plants. The shelly deposits underlying the bogs show that often they have originated around lakes, which they have filled up and covered over with a deep deposit of peat; the straggling stunted patches of *Phragmites*, *Cladium*, and such plants, not bog plants proper, which one sometimes finds far out on the great bogs, are very possibly the surviving remnant of a buried lake-flora. The flora of the bogs varies according to the amount of moisture present in the surface layer. On the wettest bogs, among a luxuriant growth of *Sphagnum*, we find the Cranberry, Bog-bean, White Beak-rush, the sedge *Carex limosa*, and the various Sundews. The bog of average wetness has a flora composed chiefly of Ling, Bell-Heather, Marsh Andromeda, Bog Asphodel, Bog-Cotton, *Scirpus cæspitosus*, with Sundews and White Beak-rush along the pool-margins. On the driest bogs the Ling grows exuberantly; Bracken and Birch, and even Brambles, put in an appearance, and most of the plants in the previous list disappear. Where the peat is drained and the original vegetation destroyed, as where the bog has been cut for fuel, plants of quite another kind, such as *Senecio sylvaticus*, *Rumex Acetosella*, and *Aira caryophyllea*, colonize the ground. Whether wet or dry, the bog-soil is quite free from lime, even when resting on limestone, and supports many strongly calcifuge plants. In striking contrast to the bogs with their peculiar plant-association, and often interspersed between them, we have the limestone pavements and limestone lake-shores of the western lowlands. The bare rock occupies a large portion of the surface; but in the cracks and crevices the gradual dissolution of the limestone and of vegetable matter has caused a rich soil to collect, which supports a highly interesting flora. Of its most peculiar members consideration must be reserved until the next paragraph. Curiously enough, many of the characteristic plants are not by any means in their general distribution especially partial to limestone—such, for instance, are the Bloody Crane's-bill, *Thalictrum collinum*, the Madder, Bear-berry, Mountain Avens—and some reason other than their calcareous surroundings must be sought to account for their remarkable abundance here.

THE SOUTH AND WEST COASTS.—Speaking generally, the conditions prevailing along the west coast of Ireland are as follows. The country is formed of old rocks, giving a rugged surface and a bold and irregular coast-line; tracts of limestone, generally of low elevation, alternate with bolder masses of metamorphic and igneous rocks; the exposure is great; the air moist and warm on account of the adjoining ocean and the

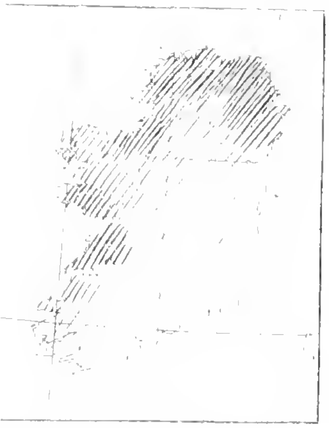


Fig. 1.—Distribution of Northern Plants (Watson's Scottish and Intermediate Types) in Ireland.

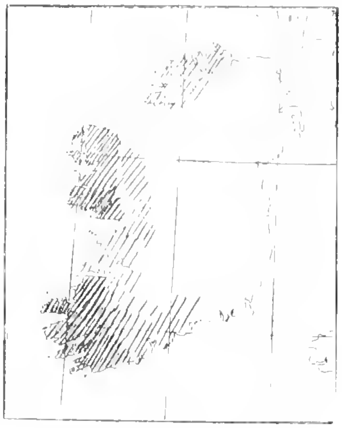


Fig. 2.—Distribution of Pyrenean and Mediterranean Plants in Ireland.

prevalence of westerly winds; there is a high rainfall and much cloud; glacial deposits are frequently absent. The effect of these conditions is to reduce the amount of cultivated land and of woods; to increase the area of bog and moor; and as regards the character of the flora, to decrease the number of plants that love a light soil, a dry climate, or abundance of sunlight; and to increase the number of mountain plants, and of species averse to the rigour of hard winters. Here the artificial element of the flora-weeds of cultivation and introduced plants of all kinds—is at its minimum; in marked contrast to the east coast, the flora of large areas is strictly natural, uninfluenced by the works of man. Among this virgin vegetation we find a group of plants—indeed, several groups of plants—which at once arrest attention by their unfamiliarity. Some of these are widely spread along the western sea-board; others discontinuously distributed; while a few have a limited local range. Most of these plants are unknown, not only in the rest of Ireland, but throughout Great Britain as well. Investigation shows that they can be divided into three groups, of widely different origin:—(1) Plants whose headquarters is in the Pyrenees or along the Mediterranean; (2) plants characteristic of the northern part of North America; (3) plants usually occurring in alpine situations, but here growing right down to sea-level. Particulars regarding the distribution of some characteristic members of each of these groups will emphasize the remarkable character of these elements of the flora.

Southern Plants. *Saxifraga umbrosa.*—In Ireland, widely spread along south and west coasts from Waterford to Donegal, avoiding the limestone. Unknown in Britain. Elsewhere confined to the Spanish Peninsula.

Saxifraga Geum.—Frequent in extreme south-west. Unknown in Britain. Elsewhere restricted to the Pyrenean region.

Arbutus Unedo.—Extreme south-west. Unknown in Britain. Widespread in the Mediterranean region.

Pinguicula grandiflora.—Common in the south-west. Unknown in Britain. Elsewhere confined to the Spanish Peninsula and the Alps.

Erica mediterranea, E. Mackaii, Dabeocia polifolia.—Three heaths confined to West Galway and Mayo. Unknown in Britain. Elsewhere found only in South-west France and Spain; the last-named extending to the Azores. Note that two other heaths, *E. ciliaris* and *E. vagans*, in the British Isles found only in the south-west of England, have the same distribution on the Continent.

Euphorbia hiberna.—Common in the south-west and extending thence discontinuously to Donegal. Devon only in Britain. Elsewhere confined to Pyrenean region.

Habenaria intacta.—Widespread on the western edge of the limestone from Clare to Mayo. Not in Britain. Elsewhere in Mediterranean region and Asia Minor.

North American Plants.—*Spiranthes Romanzoffiana.*—Found in Cork, also in the north-east. Unknown elsewhere in Europe. Of frequent occurrence in Canada and the northern United States, and in Kamtschatka.

Eriocaulon septangulare.—Spread along the west coast from Cork to Donegal. On one island in Scotland (Skye). Unknown on the European continent. Widespread in northern North America.

Low-level Alpines and Northern Plants.—The most remarkable display of these is on the bare limestone hills of North Clare, and the low limestone pavements adjoining, where *Dryas octopetala, Gentiana verna, Arctostaphylos Uva-ursi, Sesleria caerulea*, and similar plants grow, often in marvellous profusion, right down to sea-level.

As regards this third group, the peculiar climatic conditions must be held accountable for their abundance

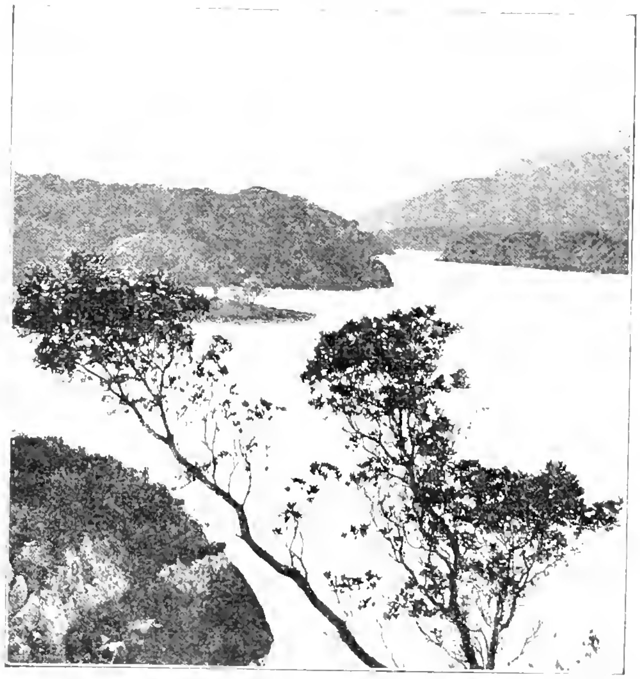
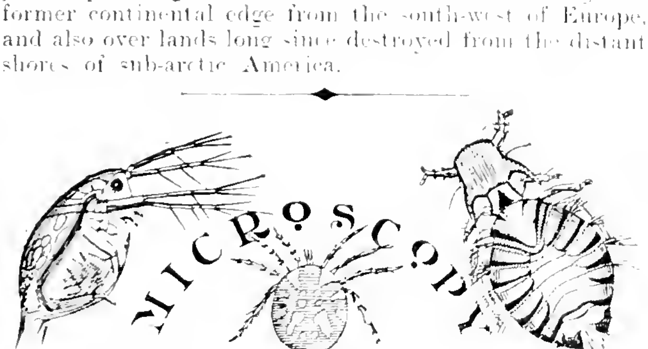


Fig. 3.—Wild Arbutus at the Upper Lake, Killarney. Macgillicuddy's Reeks (3414 feet) in the distance.

[R. Welch, *Photo.*

here—the exposure and dampness which characterize the western coast apparently mimicking the conditions which prevail in their accustomed highland haunts. But considerations of a meteorological kind, though they may help to account for the extraordinary mixing together of the northern and southern groups on the west coast, will not explain the presence of the Pyrenean or American plants. Any suggestion of introduction — early accidental introduction, say, owing to trade with Spain, or owing to seed borne across the Atlantic by the Gulf Stream — will not for a moment be allowed by botanists. These plants are natives of the natives growing abundantly in the wildest parts of the country, and avoiding the haunts of man. Neither does it appear possible that they colonized Ireland by means of the land-bridge to the eastward, which has been spoken of, for they would have left some traces of their former occupation of the wide areas over which they must have passed. To account for the presence in the flora of Ireland of the Spanish and Mediterranean elements, we must look to a period far back in the history of the island, when the continental edge extended further westward than at present, and allowed migration to proceed from the Peninsula northward across the extreme west of England into Ireland; and for the American plants, we must assume a former land-connexion across the North Atlantic, probably by way of Greenland and Iceland, joining the American with the Eurasian continent. At what period these lost lands existed it is not, with our present knowledge, possible to determine, but the distribution of these plants, and the discontinuity of their range, justify us in putting it back to a time antecedent to the arrival of the bulk of the vegetation as we now know it, and in looking upon these species as some of the very oldest components of the British flora, the remnant of an army, the date of whose invasion is lost, whose retreat has been long since cut off, and who, reduced in numbers, have been allowed, by peculiar climatic conditions, to remain to tell us of past times.

To sum up, then, the flora of Ireland may be looked on in a general way as a reduced English flora, just as the English flora may be considered as a reduced West European one; in both cases the reduction is mainly due to the breaking down of land-connections before the arrival of the whole of the plants from the great continental area to the eastward. The bulk of the flora consists of these eastern plants, most of which have colonized the entire island, though a few have not got further than the eastern margin. Northern plants arrived by way of Scotland, and spread widely, chiefly down the western side. Lastly, in the west and south we find traces of a very old flora which has migrated, probably owing to fluctuations of climate, along the former continental edge from the south-west of Europe, and also over lands long since destroyed from the distant shores of sub-arctic America.



Conducted by M. I. Cross.

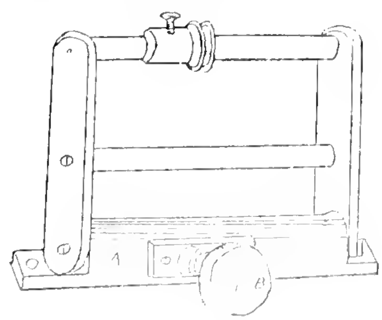
Microscopes in Schools.—During the last few months, the development of the system of "Nature teaching" in elementary schools has led to enquiry as to the most serviceable form of microscope for further developing the subject. In Scottish schools in particular, this work is to become a part of the regular curriculum, and it has been said that every school will be provided with at least one microscope, so that the senior scholars may pursue their studies in a thorough manner. In England encouragement is being given by the issue of Teacher's Leaflets of "Nature Knowledge," by the Agricultural Education Committee.

One of the main objects attempted to be achieved by these leaflets is to lead the teacher to cultivate the faculty of observation, to trace cause and effect, and to become acquainted with life histories and processes of evolution and development. If students acquire the habit of observation, they will quickly learn to think, and an added interest will be imparted to their studies by bringing them into actual touch with the secrets which the microscope can alone reveal.

It would seem almost a pity to give the scholars a compound microscope at too early a stage; pages could be written on the unnoticed structure which can be seen with a pocket lens, and it would be well that the work should be graded, and that before a compound microscope is used the worker should have acquired a facility with the pocket lens.

There is no doubt that this new study will receive encouragement, will be appreciated by the scholars and grow to large dimensions, and it will be for English microscope makers to anticipate the requirements by providing suitable instruments of sound but plain construction, and at a sufficiently moderate price; in fact, in a degree the success of the scheme so far as microscopy is concerned depends on the willingness of makers to do their part. It is impossible to foretell the influence which such teaching may have on the future of the country scientifically, and it is not improbable that it will in time to come bring an army of workers into the ranks of microscopists, and serve to re-create the interest which it is considered by many is dormant amongst amateurs at the present time. This is essentially a British movement, and if British makers supply the simple instrument, they will in due time be requisitioned for the more complete outfits which will be necessary in consequence of the desire for fuller knowledge and investigation engendered by the elementary teaching.

Focussing Attachments to Photo-Micro. Cameras.—Many ideas have been formulated for making an effective connection between the microscope fine adjustment and the long rod which actuates it from the end of the photo-micrographic camera. These have consisted principally of an endless band passing round the milled head of the microscope and a similar head attached to the rod of the camera; or a friction gear, in which a wheel shod with india rubber is arranged to engage with the microscope milled head; or a cord carried over the microscope milled head and over pulley wheels on either side of the base board having weights at the two ends, practically another form of friction movement. In practice the endless band has been the favourite, but it has possessed one drawback—it cannot be readily detached from the microscope. This difficulty was overcome by the cord with weighted ends. A very neat and simple fitting has been contrived by Mr. E. B. Stringer, which



overcomes the obstacle with the endless band. The usual milled head of the camera rod, around which the cord is passed, is mounted on a frame the lower portion of which fits into a sleeve, permitting of the rod on which the milled head is carried being tilted forward when the band is to encircle the fine adjustment milled head, or to be removed; the band is then made taut by setting the fitting vertical again, a clamping screw being provided for securing it. In this position the long camera rod connects with it and actuates it. A reference to the accompanying illustration will make the matter clear :- A is a sleeve in which the upper part of the frame is supported and can be moved forward or backward. B is the clamping screw with which it is held in position.

It may be mentioned that two or more milled heads of different sizes will often be found useful on the camera rod, for they will permit of the rate of movement being increased or diminished as may be desired.

A New Substage Condenser.—Several writers have advocated the use of a good low-power Substage Achromatic Condenser, but nothing that really filled the gap was obtainable until the introduction of Mr. C. Baker's new condenser, referred to in the April number of Knowledge. Zeiss's Achromatic Condenser was right so far as it went, but it had several disadvantages. It was large—too large—and restricted the movements of the mechanical stages, also it yielded an aplanatic aperture of less than ·70, yet the fact of its having a power of ⅓-inch caused it to be appreciated, and largely used. Messrs. Watson & Sons have just introduced a new condenser having a power of $\frac{1}{10}$-inch, and a numerical aperture of ·99, which is practically totally aplanatic. This will be found a great auxiliary to the range of condensers, especially as it possesses a sufficiently large field-lens, and is not so bulky in the mounting as to obstruct the moving plates of the mechanical stage. There is quite a comfort in using a condenser of this power with objectives of low and medium magnification.

An Experimental Offer.—There are many microscopists possessing experience who are interested in every new development, and to such, an opportunity for practically testing new apparatus would be acceptable and valuable. I have one of these new condensers of Watson's in my possession, and I am willing to send it for trial to the first four applicants who are regular subscribers of Knowledge who requisition it. I will only stipulate that it shall not be retained more than four days, and returned carefully packed. If this experiment is appreciated, it may be possible to make similar offers concerning new items of apparatus that may be described from time to time, should the makers of apparatus be willing to co-operate. I should be glad to receive suggestions and expressions of opinion on the extension of this scheme.

Object Marker.—A very neat accessory, and one that is frequently required, is a means of indicating by a mark on the specimen cover exactly where a particular structure that has been observed can be found again. Leitz makes such a fitting which replaces the objective after the required portion of the object has been found. The front portion of the marker is then brought into contact with the object, and a mark is made upon it which indicates for the future the position of the particular structure. Its cost is very small.

NOTES AND QUERIES.

J. Ogden.—If you want the very best ½-inch objective that can be obtained you must have Zeiss's Apochromatic. The Holoscope lenses of Watson's are not so well corrected for colour as the apochromatics, but are exceptionally good, being very free from spherical aberration. As you already appear to have a very good lens of this power, the better way would be to arrange with the makers for an opportunity of examining their objectives, and you could then decide whether or no you would benefit by having a new lens. I can give you no information about the other person you name.

J. F.—The ¼ in. 6 mm., and $\frac{1}{6}$ in. 4 mm. apochromatic objectives by Zeiss are certainly superior to all other lenses that are made. To derive benefit from them experience and skill are necessary; presuming that you possess this you would certainly do better with either of these than with the other that you already have, although that is a very good lens. You have to remember that special compensating eyepieces have to be used with apochromatic objectives. You have nothing to fear on the score of oxidation, the material now used is quite safe and permanent in the United Kingdom.

W. H. D. M.—I fully appreciate the value of your suggestion, which has, however, been anticipated. A further reference to the subject will be made in the next issue.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. Cross, Knowledge *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

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

Comets and their Discovery.—Brief reference was made last month to the exceptional dearth of comets in 1901. Whether this rarity is to be attributed to actual scarcity or to inadequate searching for these bodies is not clear, for we have no statistics bearing directly on the work and its results. That certain observers are engaged in specially sweeping for new comets we know by occasional announcements of their success, but we have no figures showing the extent to which these labours are pursued. Quite possibly there has recently been a want of thoroughness in the quest for these bodies; if so, it would fully account for their comparative absence in our nocturnal skies. Only one new comet has been observed during the present year, and only one of the many periodical comets known has been re-detected. It is true that the comet which suddenly appeared at the end of April and formed such a brilliant appearance in the southern hemisphere must be considered quite a notable object of its class, and it made ample amends for other shortcomings in the number of cometary phenomena; but it was scarcely visible at all in the northern hemisphere. The only other comet seen was Encke's and this faintly and inconveniently displayed itself in the morning twilight of August and September, so that very few, if any, observers in this country saw anything of it. Practically, therefore, there has been nothing in the world of comets for northern observers to see during the present year. Yet these bodies are, as Kepler said, "as numerous as the fishes in the sea," and the late Dr. Kleiber found from a theoretical investigation that the mean number of comets always present within the limits of the solar system is 5934! It is a matter for regret that comet-seeking is comparatively little pursued in England. The climate, it must be confessed, is not favourable for this or indeed any kind of astronomical work, but Caroline Herschel more than a century ago proved what could be accomplished in this attractive branch of observation with a very small telescope in able and patient hands. There is really no effective reason why English observers should not furnish a fair proportion of cometary discoveries, and the fault is to be found more in want of inclination and effort than in lack of opportunity. No doubt comet seeking, to be productive, demands a large amount of systematic and persevering application, and amateurs are seldom in a position to devote themselves to it with the necessary thoroughness. Many of them undertake a little sweeping at odd times, but are led to relinquish the work after some unsuccessful attempts. Sometimes this is brought about by the great prevalence of nebulæ, which form a serious hindrance to expeditious sweeping and occasion many difficulties, due to the necessity for ascertaining positions and making troublesome references and comparisons, so that the various objects may be identified whenever they are encountered. In Virgo, Coma Berenices and Ursa Major nebulæ present themselves in almost every sweep, and the observer is apt to get bewildered, and often finds it impossible to proceed satisfactorily. In many other parts of the firmament, however, conspicuous nebulæ are rare, and sweeping may be done with little interruption. The work becomes very entertaining after a little practice has smoothed away the difficulties, for the prospect of making a discovery is always alluring, while the very interesting objects which pass through the field serve to maintain the interest.

Showers of Telescopic Meteors in the Daytime.—Nearly every year brings us an additional record of a daytime shower of telescopic meteors (?). Mr. J. Coles, of Liphook, Hants, has just published an account of an event of this kind which he witnessed on the afternoon of September 18th last, while viewing Arcturus in a 7-in. Newtonian reflector. He says the meteors crossed the field from W. to E. at the rate of twelve a minute. A large number of descriptions might be quoted from scientific journals relating to similar showers. Thus in the *Astronomical Register* (October, 1870) Mr. C. Grover, of London, says that on July 24th, 1870, at 10h. 15m. a.m., while examining Mercury, then close to the sun, luminous objects were seen passing through the field. Sometimes ten were counted at the same instant. They varied in size from mere points to bodies fully equal the apparent diameter of Jupiter, and had sharply-defined discs, but a few were irregular. They were passing for half an hour. He used a 12¼ in. equatorial reflector. Mr. W. R. Brooks, in the *Sidereal Messenger* (Vol. II., No. 10), says that on November 28th, 1883 while sweeping about 10° over the sunset point, he observed a wonderful shower of telescopic meteors. Most of them left a faint train visible in the telescope for one or two seconds. The motion of the majority was to the northward, but with an occasional group moving southward.

There is every reason to suppose that in these and other cases the objects observed were of purely terrestrial origin, and of so light a texture that they had risen to a considerable height and were carried along by wind currents. The writer, at Bristol, has observed about a dozen good examples of these daytime showers, and they occur pretty frequently though often eluding observation. They are formed by buoyant seeds, thistle-down, snow or gossamer webs, and cannot be mistaken for "telescopic" meteors by anyone who carefully notes all the details of such appearances. Their directions are not parallel across the field, the flights of certain particles being greatly inclined to others. The velocities are different in individual cases; some of them halt in mid-field, and then suddenly run on again at a different angle. They are objects of irregular form, requiring a focus as for a not very distant terrestrial object. They cross the field in the same general direction as the wind prevailing at the time. Occasionally the showers last for several days and a change of wind brings about a corresponding variation in their directions. In fact the whole aspect and behaviour of the particles most obviously indicate their terrestrial nature, and prove them to be irregularly shaped sunlit objects, drifting along on the wind, and influenced by all its vagaries. The writer hopes during the ensuing year to make a daily search for these daylight showers with a view to ascertain their frequency, and the particular nature of the objects composing them.

FIREBALL OF OCTOBER 11.—Mr. Alex. Foote, writing from St. Andrews, Fife, says that at 8.30 p.m., he observed a fireball of great size, length and brilliancy in the northern sky. It was directed from near Capella, and disappeared among the stars of the Lynx. The colour was intense white with a tinge of blue. The meteor moved very slowly, and made a distinct fizzing noise, but there was no explosion.

THE FACE OF THE SKY FOR DECEMBER.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 7.46, and sets at 3.53; on the 31st he rises at 8.8, and sets at 3.57. Winter commences at 1 P.M. on the 22nd, when the sun enters Capricornus.

THE MOON.—The moon will enter last quarter on the 2nd at 9.50 P.M., will be new on the 11th at 2.53 A.M., will enter first quarter on the 18th at 8.35 P.M., and will be full on the 25th at 12.16 P.M. The more interesting occultations visible at Greenwich are indicated in the following table:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Dec. 14	β Capricorni	3.2	6.43 P.M.	42	9	7.29 P.M.*	278	241	3 16
„ 18	κ Piscium	4.7	7.24 P.M.	11	353	8.0 P.M.	297	272	7 17
„ 23	B.A.C. 1361	6.5	4.30 P.M.	6	47	4.45 P.M.	333	14	12 11
„ 23	ε Tauri	3.7	5.53 P.M.	9	50	6.12 P.M.	330	11	12 15
„ 27	A¹ Cancri	5.8	10.42 P.M.	105	141	11.50 P.M.	287	317	16 20

* Star below horizon.

It will be seen that three stars brighter than fifth magnitude will be occulted at very convenient hours of the evening during the month.

THE PLANETS.—Mercury is a morning star throughout the month, but after the first few days will be difficult to recognise with the naked eye.

Venus remains an evening star, and reaches her greatest easterly elongation of 47° 15′ on the 5th; at this time the planet sets at 7.14 P.M., or more than three hours after the sun. On the 31st she sets at 7.55 P.M. The apparent diameter increases from 24″ at the beginning of the month to 35″ at the end.

Mars, Jupiter, Saturn, and Uranus are too nearly in line with the sun for observation, Uranus being in actual conjunction on the 9th. On the 15th the heliocentric longitudes of the earth and these four planets are respectively 83, 303, 292, 288, and 257 degrees, from which it will be obvious that the planets are almost in line with the sun, and on the further side of it as seen from the earth.

Neptune is very favourably situated during this month, being in opposition on the 22nd. He crosses the meridian at 1.26 A.M. on the 1st, and at 11.21 P.M. on the 31st. The motion of the planet is retrograde, or westerly, in the most westerly part of Gemini. The nearest bright stars are γ and 1 Geminorum, the relative positions being indicated by the following table:

Date.	Neptune.		γ Geminorum Mag. 2.2		1 Geminorum Mag. 4.3	
	R.A. h. m. s.	Dec.	R.A. h. m. s.	Dec.	R.A. h. m. s.	Dec.
Dec. 7	6 2 12	22 15	6 32 0	+ 22 32	5 58 12	+ 23 16
„ 15	6 1 14	22 15				
„ 23	6 0 16	22 15				
„ 31	5 59 17	22 15				

Observers who are not provided with equatorials will find it easiest to identify the planet when it is near the meridian; under these circumstances the telescope should be first directed to 1 Geminorum, and left at rest for an interval of time equal to the difference in right ascensions of the star and planet, and then it should be depressed by an amount equal to the difference of declinations, estimating this from the previously determined diameter of the field of view.

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 south-west; Pegasus nearly due west; Cygnus and Lyra in the north-west; and Ursa Major a little east of north.

Minima of Algol occur on the 16th at 9.47 P.M.; and on the 19th at 6.36 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.

No. 1.

(By W. Clugston.)

1. Kt to Q6, and mates next move.

No. 2.

(By D. L. Anderson.)

Key-move.—1. Q to B5.

If 1. . . . P × Q, 2. B × B ch.
1. . . . Q to R4, 2. P to B5 ch.
1. . . . P to B4, 2. Q to Q5 mate.

After many of Black's first moves, White has a choice of continuing by 2. P to B5 ch, or 2. Q to K5 ch, or 2. B × B.

CORRECT SOLUTIONS of both problems received from W. Nash, J. Baddeley (both of whom point out that in Mr. Laws' October problem there was a mate on the move after 1. . . . P to Q4), C. C. Massey, W. Jay, G. Groom, W. de P. Crousaz, S. G. Luckock, Alpha, G. W., G. W. Middleton, W. H. S. M., H. Le Jeune, A. C. Challenger,

J. E. Broadbent, H. Boyes, C. Johnston, Vivien H. Macmeikan, F. Dennis.

Of No. 1 only from G. A. Forde (Capt.), A. E. Whitehouse.

Alpha.—It was quite understood from your previous letters that you were not a serious competitor.

P. H. Williams.—Many thanks for your pretty problems. They are marked to appear in the February number.

S. G. Luckock.—Although there is, in my own opinion, no objection to the insertion, during a solution tourney, of a problem composed by one of the competitors, it is nevertheless possible that some of the competitors might hold a different opinion. I have accordingly reserved your clever problem for next month, when the solution tourney will, except for possible ties, be no longer in progress.

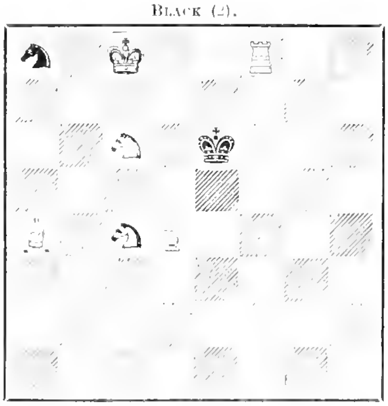
V. H. Macmeikan.—Your solutions were in plenty of time, the Sandwich postmark being the 9th. The mark of the issuing office must be not later than the 10th.

PROBLEMS.

By C. D. Locock.

No. 1.

Black (2).

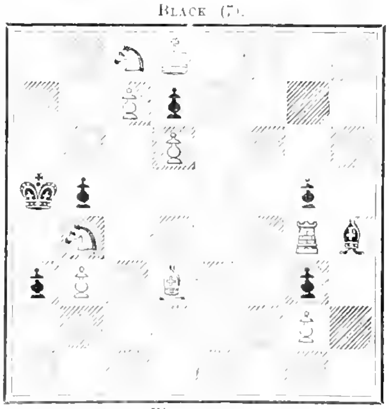


White (6).

White mates in three moves.

No. 2.

Black (7).



White (9).

White mates in three moves.

Solvers are requested to notice that both the above are three-move problems.

If five points be added to the list printed last month, that list will do for the present month, the relative positions of the first sixteen being unaltered. In the not improbable event of a tie for some or all of the prizes, the Chess-Editor proposes to take advantage of his powers, under "Condition 4," of attempting to decide the ties by "a further trial of skill under new conditions." These will probably include a four-move problem, to appear in the January number, as well as a three-move problem. The latter, in order that it may not be debarred from subsequent publication elsewhere, will be sent by post to the competitors' addresses. It is particularly requested, therefore, that all solvers who have any chance of tieing for any of the four prizes will send, with their solutions this month, the addresses which will find them on or about January 1, or during the last week of December.

A Note on Chess Theory.

Mr. Mason, I think, remarks in one of his books that capture is always, or almost always, followed by reaction. This is especially true when the capture is that of a Pawn; for not only does the player waste a move in effecting the capture, but he also presents his opponent with an aid to counter-attack in the shape of an extra open file. It follows that a player should be careful how he picks up Pawns, more particularly when the capture puts a piece out of play, or in a position subject to attack. Nevertheless, "a Pawn is a Pawn," and among first-class players it is usually numerical superiority that decides the issue. A Pawn, therefore, must be won, but it does not follow that it must always be won at the earliest opportunity. If the attack is strong enough to force the gain of a Pawn, it is generally strong enough to force the gain of something better. When, therefore, you have a Pawn at your mercy, it is often advisable, instead of taking it at once, either to attack it with another piece so as to get the option of taking it with either, or, still keeping hold of the Pawn, to threaten something else; continuing in this manner until you see your way to capture without fear of reaction. On an open board the Queen is especially suitable for tactics of this kind, which really come under the well-known axiom that to threaten is better than to perform. For example, when you have a piece capable of moving to either of two commanding squares, it is often better to play it to neither. If you commit yourself to either, the opponent will at least know what that piece means and will be enabled to shape his defence accordingly; whereas, by reserving the option, you compel him to keep on providing for both emergencies. And, if you can get him into the same state with regard to one or two more attacking pieces, he will probably find that the emergencies to be provided for outnumber his defensive resources, and that consequently his game is lost. In a word, the golden rule for attack may be stated as follows:—"Unless you clearly see your way to decisive gain, *do not make one strong move*, but *threaten to make more than one.*"

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