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KNOWLEDGE

AN ILLUSTRATED MAGAZINE OF SCIENCE LITERATURE & ART.

Founded by RICHARD A. PROCTOR.

"Let Knowledge grow from more to more."
—TENNYSON.

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INDEX.

INDEX OF THE PRINCIPAL ILLUSTRATIONS.

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CONTENTS.

COCKCHAFERS.

By E. A. BUTLER, B.A., B.SC.

WHILE the vast majority of British insects avoid obtruding themselves on human observation, and so are never seen except by nature-students who specially search for them, there are a few that comport themselves very differently, and hence are more or less familiar objects even to those who are least conversant with nature's mysteries. Such insects are of course common species, but their familiarity is not a necessary consequence of their abundance. There are many species equally, if not more, abundant, which yet are absolutely unknown to any but the professed entomologist. These well-known species attain their notoriety partly, it may be, from their size, but chiefly because they do not shun the busy haunts of men; and even in their own native woods and fields, instead of keeping under cover, they are inclined to roam, and so often encounter pedestrians. These remarks apply very forcibly to the subject of the present paper. From early childhood, all country residents must be familiar with cockchafers, and even the townsman may know something of them, provided only that bricks and mortar have not absolutely banished nature's greenery from his neighbourhood. The blind and blundering, headlong, whirring flight of the cockchafer, its proneness to enter at open windows, and cling to bedroom drapery, the pertinacity of grip it manifests when once it has alighted on curtains, dresses, or even it may be, on ladies' hair—these are all familiar experiences in the summer months. The insect, so apt thus to make itself a nuisance to the public generally, as well as a plague to agriculturists, has many interesting features and is well worth a close and detailed study.

Let us look at it first in its adult condition. A bulky, and solid-looking creature, chestnut-coloured above and black beneath, about an inch in length, with a pointed, downward bent tail, six powerful legs ending in strong hooked claws, and a pair of substantial membranous wings stowed away under two horny coverings, the whole insect dusted over with what looks like a mealy powder—such in brief is the Common Cockchafer or May Bug (*Melolontha vulgaris*) (Fig. 1). From the structure just

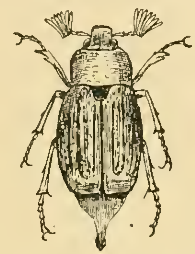


FIG. 1.—Male Cockchafer.

outlined we gather that the insect belongs to the order Coleoptera, or beetles. The mealy powder with which it is covered pretty easily rubs off, so that after knocking about for a while in the world the cockchafer begins to look threadbare and frayed, and shows its chestnut ground colour more distinctly.

The apparent mealy powder shows under the microscope as little white scale-like hairs lying side by side and pointing backwards. They are more thickly strewn in some parts than in others, and the females have a particularly dense covering of them. On the breast they are replaced by a shaggy covering of long yellowish hairs. All along each side of the abdomen, just below the edges of the wing-covers, is a row of snow-white triangular patches made of similar and still broader scales, each patch being sharply outlined and bounded by the general black surface—a striking colour scheme which vastly improves the appearance of the insect and redeems it from absolute plainness. This covering of scales and hairs makes the cockchafer an instructive insect for illustrating the gradual change of an organ of given elemental shape into one altogether different. A careful examination under the microscope will show that even the broadest of the scales are merely expanded hairs, and from different parts of the body a selection might easily be made of all varieties of these appendages ranging from the narrowest (Fig. 2), which would unhesitatingly be called hairs, through a series of minute modifications whose exact name would be doubtful, to what again would be unhesitatingly described as scales.

The last segment of the abdomen tapers away to a point which is differently shaped in the two sexes, that of the female being much the blunter of the two. This pointed tail proved in former days an irresistible temptation to the mischievous youth of England, who used to run through it a bent pin attached to a thread some eight or nine feet long. The end of the thread being held in the boy's hand, the cockchafer was tossed into the air, when of course it spread its wings and tried to fly away, but was kept like a captive balloon, struggling at the end of the string. This was the well-known and very ancient pastime of cockchafer-spinning.

FIG. 2.—Scales of Cockchafer.

FIG. 3.—Antenna of Male Cockchafer.

The sport seems to have been known even to the Greeks some 2400 years ago, but the Greek boys contented themselves with tying the string to the insect's leg instead of running it through the tail. To judge from an illuminated illustration contained in a 14th century MS., the British youth practised a similar sport with butterflies.

The wings, which are folded away most daintily under their brown covers, are of stout membrane, much strengthened along the outer border to give them the firmness of stroke necessary for raising into and maintaining in the air so bulky a body. These wings are about twice as long as their covers, and consequently have to be folded crosswise in the middle before they can be stowed away. They are the sole organs of flight, and the buzzing sound they produce has given the insects the name of "chafers," though this name is not confined to the present species, but is technically applied to the whole tribe of which it is a representative. This tribe is not numerously represented in Britain, but in tropical regions there are an immense number of species, which include some of the largest and some of the handsomest beetles in the world. The prefix "cock," which distinguishes the present species, is considered by Dr. Murray to imply strength or valour, or to have reference to the practice of making the insects fight, so that it would be equivalent to the "strong or valiant buzzer."

Unquestionably the most beautiful part in the structure of a cockchafer is the antennæ. These, again, differ in the sexes, those of the male being the more graceful and elegant. Each consists of ten joints, of which the basal one carries a brush of hairs, and the last seven are extremely short, each furnished in the male with a long leaf-like flap on its inner surface. The flaps lie close together when the animal is at rest, but when it is on the alert, they are opened out like the leaves of a book, so as to give a beautiful fan-like appearance (Fig. 3). The opening of these leaves seems to imply an attitude of attention, so that it corresponds to the pricking up of the ears on the part of a vertebrate. In the female the basal leaf is missing, the corresponding joint being furnished only with a short spine, so that there are but six leaves, and they are both narrower and shorter. Each leaf is closely covered on both surfaces with little pits or depressions, from the centre of which springs a minute hair. From their structure one can hardly doubt that they are highly sensitive organs, though it may not be easy to say what is the precise signification of their curious shape. That they are larger and handsomer in the male suggests the possibility of their having something to do with sexual selection. That they are not, however, purely ornamental follows from their sensitiveness and from the fact that the insects are quiescent in daylight, when personal attractions might count, and active towards dusk, when they could not easily be perceived.

I have spoken above of the tenacity of grip these insects manifest, and when the structure of the feet is examined, there can be no surprise that they are so difficult to dislodge. At the end of each foot are two strong hooked claws, each with a couple of teeth at the base beneath, and with the terminal portion of the claw delicately grooved (Fig. 4), all of which peculiarities help to make them effective clinging organs. In this part of her structure the female insect has the advantage, as the basal teeth are considerably larger and more powerful in that sex than in the male.

Having thus given my readers suggestions as to those parts of the cockchafer's external anatomy which are most worthy of examination, I must pass on to consider the insect in the earlier stages of its career, and to sketch its life-history. Unlike the majority of insects, it is gifted with considerable longevity, living, in one or other of its forms, through four distinct summer seasons. The eggs are laid in May, and as the larva is subterranean in its habits, the female lays her eggs underground, selecting a site for the purpose where the soil is loose and dry. She descends about six or eight inches below the surface and lays a batch of from thirty to thirty-five eggs, and she may spend some two or three days in the operation, remaining buried all the time. A few days afterwards she again works her way down through the soil and lays another batch in a different place. Three times in succession will this, as a rule, be done, and the more vigorous insects will even lay four batches of eggs. The number diminishes somewhat in the successive batches, but we may say that each vigorous female cockchafer may become the parent of from sixty to eighty young, a rate of multiplication which easily explains the enormous numbers of the insects which are sometimes met with. A little calculation will show that if a female lays on the average sixty eggs, and if no more than one-third of these on the average produce females, yet in about twenty years, the descendants then alive of the female cockchafer would amount to upwards of 180 millions, supposing that no

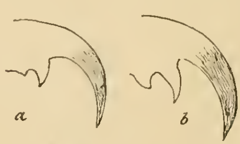


FIG 4.—Claws of Cockchafer. *a*. Male. *b*. Female.

FIG. 5.—Larva of Cockchafer.

accidents have happened. That the insects do not appreciably increase in numbers therefore shows how extensive the chapter of accidents must be. The mothers seem to suffer from a disease which sometimes brings about the putrefaction of the eggs before they are laid, while the armies of rooks, jackdaws and other birds make persistent and successful warfare upon the larvæ.

About six weeks after the laying, the eggs, which are at first oval, but afterwards become almost spherical, hatch, producing little fat whitish grubs, each with six legs close behind the head, and a pair of good biting jaws on their disproportionately large heads. Their food consists of the roots of plants, and during the latter part of one summer, the whole of a second, and the first part of a third, they spend their time in nibbling these roots, whereby they of course either seriously weaken or altogether destroy the plants attacked. The amount of damage, therefore, that one of these grubs can do during its two years' course and more, is very considerable, and as the work of devastation is all carried on beneath the surface of the ground and thus out of sight, its prevention is correspondingly difficult. Man, in fact, must rely largely upon workers whose senses are more acute than his own if these grubs are to be detected in their clandestine work. And here it is that the rooks and jackdaws aforesaid come in useful, their acute sense of hearing enabling them to detect the movements of the grubs as they work their way through the soil, and of their jaws as they enjoy their subterranean repast. In winter the grubs go deeper into the ground, where they will be out of the reach of sudden changes of temperature.

In the third year of its existence, the grub is full-grown (Fig. 5) and about an inch and a half long, with a shiny chestnut-coloured head, and three pairs of legs similarly coloured. The hinder part of the body is always bent round in a semi-circle towards the head, and is very much swollen, the dark-coloured contents of the intestines showing plainly through the thin skin. When the grubs are quite young, the damage they do is inconsiderable, and is confined to the tenderer and more delicate root fibres, but during their second and third years they are exceedingly voracious and devour an enormous amount of food, not neglecting even the coarser root fibres which had before been too much for their jaws. There is probably a certain small balance of agricultural benefit to be set over against the damage they commit, because their tunnelling movements serve to loosen the soil, and while they are devouring their proper food, they necessarily swallow a good deal of earth and so perform services analogous to those rendered by earthworms.

In the July of its third summer, the grub goes down to a depth of about two feet and there excavates an oval cell, which it lines with a gummy secretion. Here, throwing off its last larval skin, it changes into a chrysalis, which, like those of beetles generally, shows plainly all the parts of the future insect—legs, wings and antennæ, bent round to its under surface and tightly enclosed in a thin skin. The chrysalis stage is a very brief one, lasting only for about a month. Then another and final moult takes place, and the insect appears a full-grown and perfectly formed, though soft-skinned, cockchafer. By the end of August, then, or at latest, the beginning of September, it has completed its cycle of changes, but it is by no means ready for the active business of adult life. In fact, it remains in its cell underground shut up for the winter, and destined to lie helplessly there in company with its last two cast skins till the genial days of spring summon it to the surface. By about the 20th of April, close upon three years after its mother laid the egg from which it was hatched, its skin has suitably hardened, and it performs its first feat in tunnelling as a perfect insect by making a shaft, up which it travels to the open air and the sight of the country around, which it thus beholds for the first time in its existence.

Once above ground, the cockchafer climbs up into trees, having a particular liking for oak, beech, chestnut, poplar, and elm, upon the young leaves of which it now begins to feed. It has still some seven or eight weeks to live, and that time, which will be a busy one, has to be spent in providing for the coming generation. Frequent pairings take place, and the intervals between the courtships or egg-layings are spent in feasting, both the sexes recuperating their energies by devouring great quantities of the leaves of the before-mentioned trees, or failing them, of whatever else can be found. Thus the insect, in its early stages a devourer of roots, becomes, when fully grown, addicted to leaves and green herbage generally, a curious change of diet which suggested to an old writer the following quaint reflections:—"This seems one of the wise Contrivances of Nature, that adapts as most proper the Airy finer nourishment for the more agile and light Body of the Volatile Insect, while the same Animal, when a dull Reptile Worm, is sustained by a more gross and terrene Food, more fitting to its slow and heavy Nature." Both the sexes are excellent diggers, and the male frequently goes beneath the surface as well as his partner, though for what purpose it is not easy to say. The powerful spurs on the fore-legs, which are always found in digging insects, are no doubt useful in excavating the burrows. Though most abundant about May or June, the insects may be found more or less frequently all through the summer, the males being met with, at least in this country, much more commonly than the females. The insect has now come to the end of its career; by the time autumn is over they have disappeared, and it seems that none are left to hibernate.

The unusual length of the larval life produces a periodicity in the appearance of the adults which has some remarkable features. For example, the adult cockchafers which were to be found during the now closed season of 1901, were not the descendants of any that might have been seen in the preceding year, but sprang from those which appeared in 1898. These latter laid their eggs in the early summer of 1898, and the grubs lived underground during the years 1898, 1899, and 1900, becoming pupæ in July, 1900, and perfect insects in August of the same year, but not appearing above the surface till April, 1901. It appears, therefore, that the swarms of cockchafers should be seen every third year, and this, at least on the Continent, is certainly the case. But the remarkable fact is that the year is not the same one in all parts. For example, Switzerland may be mapped out into three distinct regions, in which the cockchafer year falls on different dates. Thus in the region near Basle, the cockchafer year occurs when the date of the year divides by three without a remainder; in the Berne district when it divides by three with a remainder of one, and in the Uri district when the remainder is two. Thus 1899 was a cockchafer year at Basle, 1900 at Berne, and 1901 at Lucerne. Thus it follows that three generations of cockchafer grubs are at the present moment living in the soil in different places, destined in their turn to yield the adult insects of the years 1902, 1903, and 1904.

We have said that the males are more frequently seen than their partners, and this is particularly the case in the pairing season, when large assemblages of males may be noticed in the evening circling like a swarm of bees round the tops of trees or over the gable-ends of houses. When the insects are plentiful, they often lose their foothold in the trees in the daytime and drop to the ground, when they are eagerly sought after by swine and poultry. In the year 1688, enormous swarms appeared in the west of Ireland, and the pigs seem to have flourished upon them.

Besides the common cockchafer, another insect, of somewhat similar appearance, but smaller, much more hairy, and without the white scales and triangular patches, is also met with in this country, though perhaps not quite so commonly. It is sometimes called the July Bug (*Rhizotrogus solstitialis*), and has habits similar to those of *Melolontha*. Another insect, nearly allied to these, and much handsomer, is that known as *Phyllopertha horticola*. It goes by a variety of local and popular names, such as bracken clock, fernweb, fernshaw beetle. It is considerably smaller than either of the others, hairy, and with a metallic green thorax and reddish wing covers. It sometimes does considerable damage to gardens, as well as to pasture land. It is often found in strawberry beds, and is particularly common in the eastern counties. Canon Fowler says that this beetle is a good bait for trout, chub, and other freshwater fish. The common cockchafer, as being an easily procurable insect, has been often used as a typical instance of insect structure; its anatomy was very fully worked out by Strauss-Dürckheim, and it has been used for experiments in insect locomotion.

ANIMAL PERFUMES AND THEIR ORIGIN.

By R. LYDEKKER.

ALTHOUGH fashionable enough in former days, the three chief perfumes of animal origin, namely, civet, ambergris, and musk, have steadily declined in popular favour in their unmixed condition, and are now chiefly employed to form a basis for other scents of a less powerful nature. All three are products of mammals, and all appear to have been known from very ancient times indeed, although much misconception was long prevalent with regard to the real origin and nature of the second.

Nowadays naturalists are almost universally in the habit of calling the animals from which the first-named of the three is obtained "civets," although in popular language they are termed "civet-cats." Apparently there is little doubt that the latter usage is correct, the name civet being properly applicable to the perfume itself rather than to the animal by which it is secreted. In a well known dictionary we find, for instance, the following:—

"CIVET, *n.* [Fr. *civette*; Ar. and Per. *zabad*.] The sweet scent of any beast; a semi-fluid substance taken from under the tail of the civet-cat and used as a perfume. *vt.* To scent with *civet;* to perfume."
"CIVET-CAT, *n.* The animal that produces civet."

Again, in Shakespeare and other early writers the word civet is invariably employed to designate the perfume itself.

Of civet-cats, to give them their full title, there are several distinct species, the typical representative of the group (*Viverra civetta*) being African, while the others are inhabitants of India and the Malay countries. These animals, the largest of which is about the size of a cat, while the smallest may be compared with a pine-marten in size, are near relatives of the genet and the palm-civets, and more distant cousins of the mongooses. Their affinities with the cat tribe are comparatively remote, although, in spite of their long and pointed muzzles, they are much more closely related to those animals than they are to the dogs. They are coarse-haired, flat-sided creatures with small ears, partially retractile claws, a long tapering tail, and generally a crest of long hairs running down the middle of the nape and back. The ground-colour of the fur is greyish, upon which are streaks or blotches of black or blackish brown, the tail being ringed with black. The most striking and characteristic feature of their coloration is, perhaps, the black gorget on the throat. The civet, which is a white fatty substance, is contained in two small pouches, or infoldings of the skin, situated beneath the base of the tail.

To obtain the civet the animals are kept in confinement enclosed in long cages so narrow that they cannot turn round. Two or three times a week the back of the cage is opened, and the animal dragged by its tail close up to a cross-bar, when the civet is carefully scraped out of the pouches by means of a wooden spoon or spatula. When collected the perfume is carefully enclosed in an air-tight vessel. The amount of civet yielded depends, it is said, to some extent upon the food on which the animal is fed. If the civet be not periodically removed, some of it is discharged by the animal itself; and the walls of the cages of the civet-cats in the Zoological Gardens are frequently smeared with this odoriferous substance, which is carefully collected by the keepers.

A very large amount of commercial civet is yielded by the large African civet-cat, already mentioned, but the large Indian species, or zibeth (*Viverra zibetha*), which derives its name from a corruption of the Arabic and Persian designation of the perfume, is probably equally prolific in this respect. The smaller oriental civets, the smallest of which—the rasse—has been introduced into Madagascar, yield, of course, a less amount of this valuable substance.

Formerly, at any rate, civet-cats were kept in Holland for the sake of their perfume, as is attested by the following extract from Hutton's translation of Buffon's Natural History, published in 1823:—

"In Holland, where no small emolument is derived from their perfume, they are frequently reared. The perfume of Amsterdam is esteemed preferable to that which is brought from the Levant, or the Indies, which is generally less genuine. That which is imported from Guinea would be the best of any, were it not that the negroes, as well as the Indians, and the people of the Levant, adulterate it with mixtures of laudanum, storax, and other balsamic and odorous drugs."

Roughly speaking, about twenty thousand ounces of civet are annually imported into London; of pure Jeddah civet the value is eight shillings and sixpence per ounce, of "commercial" civet seven shillings.

Very different to civet, both in character and in origin, is the substance known as ambergris. The name of this very remarkable substance is of French origin, *ambre-gris*, signifying grey amber, or rather perhaps grey perfume, the word amber itself (Fr. *ambre*) referring to the odoriferous qualities of the substance it designates, as is exemplified by the verb *ambre*, to perfume.

Ambergris is generally found floating on the surface of the sea, and very different ideas have been entertained as to its nature and origin. It appears, however, that so early as the middle of the sixteenth century it was known to have some connection with whales; although the nature of this connection was not fully realised. One writer, for instance, in describing a sperm-whale stranded on the Norfolk coast, expresses his surprise at not finding ambergris in its stomach. Although the idea that ambergris is swallowed by the sperm-whale is erroneous, the writer in question was quite correct in regarding that substance as pertaining to this particular species of cetacean.

A century later the original idea of the association of ambergris with whales seems, however, to have been abandoned in favour of a notion that it was the gum of a tree. On the other hand, in an early edition of

Johnson's Dictionary (1818) it is described as being either floating honeycomb or guano.

Buffon, however, was fully convinced of its cetacean origin; and in the translation of his work already cited we find the following passage in connection with the sperm-whale:—

"As to the ambergrise which is sometimes found in this whale, it was long considered as a substance found floating on the surface of the sea; but time, that reveals the secrets of the mercenary, has discovered that it chiefly belongs to this animal. . . . It is found in a bag of three or four feet long, in round lumps, from one to twenty pounds in weight, floating in a fluid rather thinner than oil, and of a yellowish colour. There are never seen more than four at a time in one of these bags; and that which weighed twenty pounds, and which was the largest ever seen, was found single. These balls of ambergrise are not found in all fishes of this kind, but chiefly in the oldest and strongest."

While there is much of truth in this account, there is a certain amount of error. As a matter of fact, ambergris is usually found floating at sea, or more generally cast up by the waves on the shore. The fact that it contains the horny beaks of squids and cuttles belonging to species that form the food of the gigantic sperm-whale, or cachalot (by far the largest of the cetaceans furnished with teeth), is alone sufficient to indicate that it is a product of that monster. And from time to time it is actually found in the alimentary canal of that whale. It appears, indeed, to be a biliary concretion, closely analogous in its nature to bezoar stones, and due to the existence of disease in the individuals in which it occurs. In place, therefore, of being found only in old and strong specimens, it is generally at least met with rather in those in poor condition or which have died a natural death. The bags containing ambergris mentioned in Buffon's account would appear to be portions of the whale's intestines which have been cut out and tied up with their contents.

When first taken from the sperm-whale's interior ambergris is a soft greasy substance, exhaling an exceedingly disagreeable odour; and it is only after exposure to the air that it hardens and acquires its characteristic aroma, which is described as being sweet and earthy. As its name implies, ambergris is of a grey colour.

The largest piece of ambergris known to Buffon, as above stated, weighed twenty pounds, but masses largely exceeding this have since been recorded. A piece weighing one hundred and thirty pounds, the value of which was fully five hundred pounds, is, for instance, definitely known, while according to Messrs. Van Beneden and Gervais a mass weighing no less than nine hundred and eighty-two pounds is stated to have been at one time in the possession of the Dutch East India Company. According to information kindly supplied by Messrs. Piesse and Lubin, the average amount of ambergris imported yearly into this country may be put down roughly at one thousand pounds. In a recent trade circular the value of "fine grey" is given as one hundred and twenty-five shillings per ounce, and of "fine black" seventy shillings.

Formerly ambergris found a place in the pharmacopœia, but its sole use at the present day is in perfumery, mainly as a base for other scents of a more delicate nature.

The third substance on our list—musk—is the product of the male musk-deer, or kastura (*Moschus moschiferus*), of the Himalaya and Central Asia, a hornless ruminant of about the size of a small goat. In many respects, such as the possession of a gall-bladder to the liver, this animal approximates to the hollow-horned ruminants, although it is generally regarded as an aberrant member of the deer family. In addition to a rough coat of very coarse and almost pith-like hair common to both sexes, the musk-deer is specially characterised by the presence of a pair of long scimetar-like tusks in the upper jaw of the male, as well as by a peculiar pouch situated in the groin of the same sex yielding the perfume from which it derives its name.

Although by some writers the name *Moschus* has been derived from μόςχος, the Greek for a calf, it really appears to have a totally different origin. For instance, in the dictionary from which one quotation has been already made in an earlier part of the present article, we find the following item:—

"Musk, *n.* [L., *muscus*; Pers., *mashk*; Ar., *musk*; Hind., *mushk*, *misk*; late Gr., *moschos*, the same as *oschos*, a bag.] A strong-scented substance obtained from a *cyst* or *bag* near the navel of an animal that inhabits the mountains of Central Asia; also, the animal itself. *vt. To perfume with musk.*"

From this it appears that the word musk originally means the bag in which the natural substance is contained. The origin of the name kastura (the first *a* pronounced as the *u* in musk) is less easy to ascertain, but it appears evidently connected with castoreum, the aromatic product of the beaver.

The musk bag, or "pod," is cut out from the animal after death, and when full contains about an ounce of musk. At the time when the rupee was worth two shillings or over, the value of a musk-pod in the Indian bazaars was about one pound sterling. The amount of musk in a pod varies according to season, and the age of the animal; apparently the pods are full only during the pairing-season. When properly taken, the odour of musk is so strong as to cause headache in those by whom it is inhaled. And so enduring is the scent that a piece of musk may be preserved in a room for years, and at the end of that period will be almost as odoriferous as at first.

Messrs. Piesse and Lubin estimate the annual import of musk into England roughly at ten thousand ounces. Several descriptions and qualities are recognised in the trade, as may be seen from the accompanying extract from a recent commercial circular, where the wholesale prices are quoted:—

"Tonquin Pile	I.	... ...	per oz.,	75/- to 80/-
„ „	III.	... ...	„	32/6 to 50/-
„ grain		... ...	„	90/-
„ „	pure	...	„	110/-
„ „	comt.	...	„	65/-
Assam „		... ...	„	60/-
Cabardine „		... ...	„	45/-
Nepal „		... ...	„	40/-"

In addition to being employed largely in perfumery, musk is also used in the confectionery trade.

Of less importance than either of the preceding in the perfumery trade is *castor*, or *castoreum*, the secretion of the beaver, of which, according to information kindly furnished by the well known firm of perfumers above mentioned, about one thousand pounds are annually imported into England, at a value of about twenty shillings per pound. Although the use of this scent in perfumery is limited, it is very largely employed in the preparation of Russia leather, to which it communicates the well-known odour.

From accounts dating as far back as the year 500 B.C., it appears that beavers were originally hunted for the sake of their castoreum alone, the felting properties of their fur not being discovered till centuries later.

The castoreum is contained in a couple of pouches situated in the groin of the beaver, which when extracted and dried are not unlike two pears; about six pouches going to the pound. In olden times castoreum was regarded as an almost universal panacea, and its value was proportionately high. Although this substance no longer appears in the pharmacopœia, in America, according to the author of *Castorologia*, "the belief in the miraculous properties of the castoreum is still shared by so many, that the crude article is even now regularly sold in our drug stores, and its value steadily increases so that quotations of from eight to ten dollars per pound are current for the rough Canadian 'castors' as the pouches are sometimes called, while the Russian article is even more valuable."

It may be added, as a somewhat remarkable circumstance, that the castoreum of the American and Old World beavers differs remarkably in chemical composition, the former containing 58.6 per cent. of resin and 2.6 per cent. of calcium carbonate, while in the latter we find only 13.8 per cent. of the resin and as much as 33.6 per cent. of the carbonate. The reason for this extraordinary difference is not easy to suggest.

Two other perfumes of animal origin, namely, "musquash" and "musk-rat" are recognised in the trade, but, according to information communicated by Messrs. Piesse and Lubin, are at the present day of no commercial value, the former being too rank, and the latter too faint. It is a little difficult to trace the origin of these two perfumes, since the "musquash" and "musk-rat" are one and the same animal—*Fiber zibethicus*, a North American relative of the water-vole. Possibly the two kinds of perfume may be taken at different seasons, or may be the product of different sexes.

Yet another substance of animal origin, held in great estimation in the east, both as an antidote to poison and as a remedy against all kinds of disease, may be appropriately noticed in this place. This is the celebrated bezoar, which is commonly believed in Persia to be obtainable only from the wild goats (*Capra hircus ægagrus*) inhabiting the hills between Karman and Shiraz, although it doubtless occurs in those of other districts, and probably also in other species of wild goats or ibex. The name bezoar, according to the late Sir O. B. St. John, is Persian, and should properly be *pa-zahr*, a corruption of *fa-zahr*, which means "useful (for) poison." Bezoar stones are concretions formed in the stomach of certain individuals of the wild goat, and vary considerably in size, shape, and colour. A specimen described in Blanford's "Zoology and Geology of Eastern Persia" was egg-shaped, and measured three-quarters of an inch in length; its colour being dark olive and the surface highly polished. In Persia bezoars are greatly valued, and in addition to being used as a medicine and as an antidote to poison, are sometimes worn by the women as amulets or charms, encased in gold filigree work.

SPECTRUM OF LIGHTNING.

PHOTOGRAPHS of the spectrum of lightning were obtained on July 18 and 21, 1901, by Mr. J. H. Freese, under the direction of Mr. Edward S. King. The 8-inch Draper Telescope was used with an objective prism. The telescope was directed to the portion of the sky in which the lightning was particularly bright, and when the observer thought that he had obtained an image, the plate was changed. Even then many of the plates were badly fogged. A number of photographs were taken in this way, and showed the curious fact that the spectrum of lightning is not always the same. One flash, on July 18, showed three bright bands, while another taken on the same evening showed ten bright lines, and closely resembled one taken on July 21. The latter is shown in Figure 1. To increase the contrast

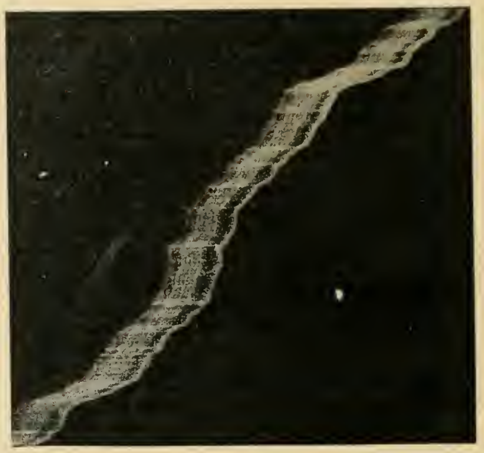


FIGURE 1.

of the original negative a double contact print was made from it with slow plates, and is reproduced in the figure on the original scale. The brighter portion of a second flash, clearly seen in the original negative, also appears in the print. Measures, each consisting of three settings, were made of three portions of the principal spectrum, and the means of the results are given in Table I. The original negative was an isochromatic plate. The successive columns give the hydrogen lines with which certain of the lines are assumed to be identical, the mean wave length and intensity of the lines in the spectrum of lightning, and the wave length and intensity of the principal lines in the spectrum of Nova Persei, No. 2, on March 23, 1901.

TABLE I.

SPECTRA OF LIGHTNING AND NOVA PERSEI.

Hyd.	W. L.	Int.	W. L.	Int.	Hyd.	W. L.	Int.	W. L.	Int.
Hη	......	...	3836	4	Hγ	4341	5	4341	10
Hζ	3881	10	3889	5		4441	?	4468	4
Hϵ	3956	2	3970	7		4519	1	4573	3
	3998	3				4643	8	4646	6
	4046	2	4030	2		4754	1	......	...
Hδ	4102	8	4102	8	Hβ	4861	5	4862	10
	4147	4	4149	1		4940	?	4925	1
	4187	?	......	...		5022	2	5015	3
	4222	5	R	2		5173	1	5171	3
	4263	1	......	...		5595	30	R	20

The first line in the spectrum of lightning is a broad, bright band, extending from wave length 3830 to 3930, and is perhaps identical with the nebular line 3875.

The line 4222 appears as a broad band in the Nova. The last band is very broad or perhaps a continuous spectrum extending in both objects from about wave length 5300 to 6000. The lines in the two spectra appear to resemble each other closely both in position and in intensity. On September 15, 1901, a photograph was obtained with the 11-inch Draper Telescope, showing nearly thirty bright lines. Some of these show a curious doubling, the separation varying in different portions of the flash. Apparently, this is due to another flash, in whose spectrum only a portion of the lines appear.

Edward C. Pickering.

November 16, 1901.

CONSTELLATION STUDIES.

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

XII.—THE GREAT HUNTER AND HIS DOGS.

The long nights of winter are the time when the heavenly hosts gather in their most resplendent squadrons. Sirius, by far the brightest of all the fixed stars, reaches the meridian at midnight of New Year's Day. Orion, the most splendid single constellation, is crossing from 10.30 to 11.10, the same night. Procyon, the Lesser Dog star, follows Sirius in its southing by about forty minutes. East and west of these are the two bright zodiacal constellations of the Twins and the Bull. South and east of Sirius is the hugest of the constellations, the ship Argo, resplendent with many brilliant stars, but distinguished amongst all the stellar groups by the numbers and the compact clustering of the small stars just clearly within the grasp of the unaided sight. Aratus marks the special glory of this region, though Dr. Lamb fails, as he too often does, to represent his exact meaning.

> "First rise athwart the Bull—majestic sight,
> Orion's giant limbs and shoulders bright,
> Who but admires him stalking through the sky,
> With diamond-studded belt and glittering thigh.
> Nor with less ardour, pressing on his back,
> The mottled Hound pursues his fiery track.
> Dark are his lower parts as wintry night,
> His head with burning star, intensely bright,
> Men call him Sirius, for his blasting breath,
> Dries mortals up in pestilence and death."

Both the Authorised and the Revised Versions of the Bible refer the Kesil of Job xxxviii., 31, to this constellation. There is much probability that the rendering of the Revised Version for the other two constellation names mentioned in this text, Aish and Kimah, "the Bear" and "Pleiades," are quite correct, but there is more uncertainty in the present identification. Kesil means "impious, mad, rebellious," and as such is traditionally supposed to refer to Nimrod, "the mighty hunter before the Lord," supposed to be the first great conqueror, and the first to set up a tyranny based upon military power. One difficulty in rendering Kesil by Orion is that the same word occurs in the plural in Isaiah xiii., 10, where the word is translated "constellations." If Kesil, therefore, really refers to Orion we must suppose that in this passage the most glorious constellation of the sky is put for constellations in general. The context, however, would rather lead to the idea that we should look for a winter constellation to correspond to Kesil; for just as "the sweet influences of the Pleiades" evidently refer to the revival of nature in the spring, so "the bands of Orion" may be naturally supposed to point to its imprisonment by the cold of winter. If Nimrod be really the original Orion, there was an unsuspected appropriateness in the sycophantish proposal of the University of Leipsig to give the centre stars of the group the name of Napoleon, the most modern example of the same mad ambition.

Brown traces the name Orion to the Akkadian Ur-ana, "the light of Heaven," a poetical and most natural title for the most beautiful and brightest of all the stellar groups. And it may well have been that, as Brown further thinks, this name was given because the constellation was taken as a stellar reduplication of the one great light of heaven, the sun, or the same name having been given independently to both the sun and the constellation, the latter was taken as representing the former. The stellar giant, therefore, on this view presents to us a personification of the sun, "rejoicing as a giant to run his race."

But what does he pursue? His prey is found in the little constellation beneath his feet, one of no distinction or brilliancy, the Hare.

> "Up from the east the Hare before him flies,
> Close he pursues her through the southern skies."

Now it is certain, as Brown points out, that "the amount of folklore and zoological myth which all over the world connects the moon and the hare is simply astonishing." Of course it does not necessarily follow that the Hare as a constellation is also a symbol of the moon, but at least the suggestion has no improbability. It is possible, therefore, that in Orion the mighty hunter trampling on the timid fleeting hare, we ought to recognise a primeval emblem of the rising sun overpowering and crushing with his vastly more powerful light the feebler rays of the moon as she flees before him towards the west. But whether the two Dogs which we find attending and following Orion have any deeper meaning than the natural desire to piece out this picture of a hunter and his chase, by providing him with a leash of hounds, may well be doubted.

The figure of the giant hunter is one of the very easiest to make out of all the constellation figures. Seven bright stars stand out with special distinctness. That furthest to the north-east of the seven is obviously orange in colour, and is Alpha, Betelgeuse, "the shoulder of the giant." The star in the north-western corner is Gamma, Bellatrix, "the female warrior." This last title is from the translation in the Alphonsine Tables of the Arabic title Al Najid, "the conqueror." The south-western corner is held by Beta, Rigel, the "foot," the brightest star of the constellation. The fourth corner, the south-eastern, belongs to Kappa, now known as Saiph, "the sword," the name having been transferred to this star from Iota, to which it really belongs. Three stars mark the Belt of the giant, as the four foregoing mark his two shoulders and his legs. These in succession are, Delta, Mintaka, "the girdle"; Epsilon, Al Nilam, "the string of pearls"; and Zeta, Al Nitak, "the belt." The sword is marked by a short row of stars in a straight line below Epsilon. These are, 42, Theta and Iota. Theta, to the eye, is a misty star; its diffused appearance being due to the great nebula, the most glorious object in the heavens. Between Alpha and Gamma, but a little to the north, is a compact little triangle of stars, Lambda and Phi 1 and Phi 2, which mark Orion's head. His club stretches up across the Milky Way to the feet of Gemini and the horns of Taurus, whilst between Bellatrix and Aldebaran a curving line of stars runs nearly due south, marking the lion's mane, which the Hunter is shaking before the eyes of the Bull, as if it was the scarlet cloak of a toreador.

The little constellation of the Hare does not contain much of interest for the naked-eye observer. Its principal star, Alpha, sometimes known as Arneb, "the hare," is very near the point of an equilateral triangle, of which Beta and Kappa Orionis form the base.

A far more majestic triangle, and more nearly exact in its proportions, is that formed by Betelgeuse, Sirius and Procyon.

"Let Procyon join with Betelgeuse and pass a line afar,
To reach the point where Sirius glows, the most conspicuous star;
Then will the eye delighted view a figure fine and vast;
Its span is equilateral, triangular its cast.

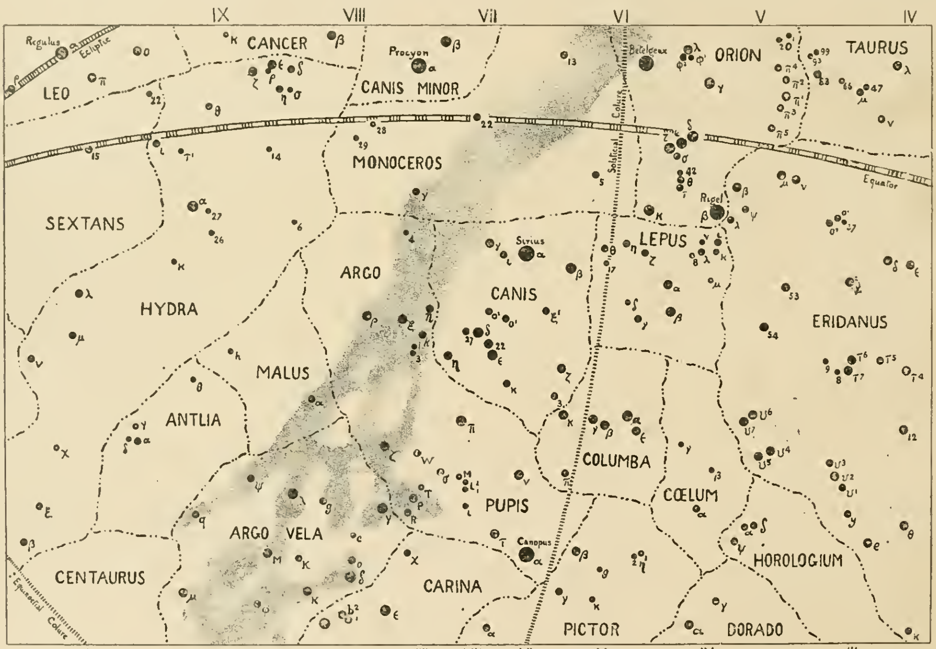
The constellation of Canis Major, though in itself a brilliant one, lies so low for English observers that practically we think of little but its chief star. But this is so far and away the brightest in the sky, being more than two full magnitudes brighter than the average first magnitude star, such as Aldebaran or Altair, and is rendered so unusually striking by the intensity of its scintillations, that it serves alone to amply distinguish the constellation to which it belongs. Its excessive scintillation is due to two causes; the one that in these latitudes it can never attain any great elevation; the other, its striking bluish-white colour. For stars of that colour scintillate more markedly than those of any other, and Sirius being the very type and model of the class, its flashing renders it as conspicuous as its brightness.

"The fiery Sirius alters hue,
And bickers into red and emerald."

The name Sirius is usually taken as bearing its Greek meaning of "sparkling," "burning," or "scorching," an appropriate enough name for the brightest of the stars and one in conjunction with the sun at the beginning of summer. Other renderings interpret it as "chief," or "prince," or "the bright and shining one"; all equally natural and appropriate for this prince of stars. Our name for the Lesser Dog, Procyon, is simple enough. It is merely "before the dog"; in other words, Procyon was the forerunner of Sirius, not as crossing the meridian earlier, but as rising before it and so heralding its appearance.

The colours of the four brightest stars of this region are very well worth studying; the orange of Betelgeuse being in strong contrast with the steel-blue of Rigel and Sirius, whilst Procyon, though a white star, yet shows a distinct creamy or yellowish tinge, which to a sensitive eye is on a fine night very clearly distinguishable from the colder hue of the two brilliants first named.

The constellation of the Lesser Dog in Ptolemy's Catalogue numbers only one star in addition to Procyon. This is Beta, Gameisa, the "dim-eyed," possibly as meaning that Procyon is so much less brilliant than Sirius.

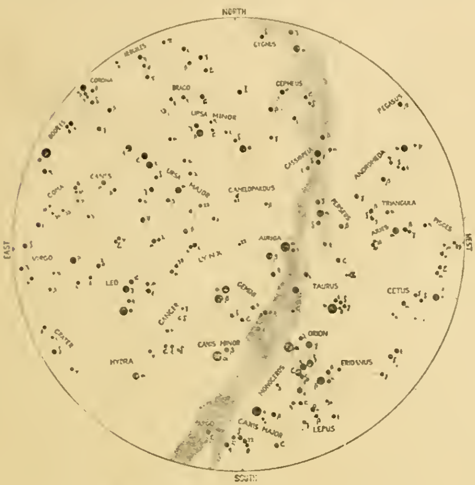


Star Map No. 12; The Great Hunter and his Dogs.

Or it may be that it is a corruption of Al Gamus, the "puppy." A glance at the sky shows that Procyon and Gameisa stand at much the same distance apart as Castor and Pollux, and the Arabian astronomers used to call the space between the two stars of the Twins "the long cubit," whilst that between the two of the Lesser Dog was "the short cubit,"—an old instance of the tendency, which seems so irresistible, to account a space in the heavens of some seven to ten degrees of arc in length as equivalent to a terrestrial yard.

Procyon and its companion form yet another proof that the constellation names were not given in consequence of forms suggested by the actual groupings of the stars. Certainly there is nothing to suggest a dog in the presence of two fairly bright stars some five degrees apart.

The Greater Dog is a far fuller constellation. Beta precedes Sirius some twenty-two minutes and is therefore called Murzim, the "Announcer." Quite low down near our horizon is a right-angled triangle of bright stars, the right angle being marked by Delta. Epsilon and Eta at the two other points of the triangle lie some three degrees further south and are nearly on the same



The Midnight Sky for London, 1902, January.

parallel with each other; Epsilon is Adhara, the "back." Delta is in the centre of a very interesting region, a curious curve of small stars preceding it, whilst another follows.

Argo is scarcely at all an English constellation, the greater part of its huge bulk lying below our horizon. The vessel is drawn in our atlases and described by Aratus as travelling stern foremost. Thus in Brown's translation we read:—

> "Stern forward Argo by the Great Dog's tail
> Is drawn; for her's is not a usual course,
> But backward turned she comes, as vessels do
> When sailors have transposed the crooked stern
> On entering harbour; all the ship reverse,
> And gliding backward on the beach it grounds.
> Stern forward thus is Jason's Argo drawn."

The Greek legend of the voyage of the Argonauts under Jason to recover the Golden Fleece was believed by Sir Isaac Newton to have an actual historical basis, and to record the beginning of Greek commerce. In fact in his view the constellations generally were designed by the Greeks to celebrate the heroes and deeds of this great expedition. The knowledge which later times have brought us have compelled us to recognise that the constellations are far older than Newton thought them, and beyond a doubt Proctor was quite correct in recognising in Argo and the southern constellations near it,—Centaurus, who is represented as having apparently just left the ship and the Altar at which he is sacrificing,—a pictorial record of that great Deluge of which the Hebrew and the Babylonian accounts agree so strikingly. The Altar lies entirely below our English horizon; the Wolf, the somewhat inappropriate animal whom the Centaur is offering up, shows but two or three faint stars; and Theta Centauri, the star in the Centaur's head, is the only bright member of that constellation visible to us.

THE PROGRESSIVE SPECTRUM OF NOVA PERSEI BETWEEN FEBRUARY 22 AND NOVEMBER 28, 1901.

By Rev. Walter Sidgreaves, s.j., f.r.a.s.

The new star is already old while its birth and rapid growth are fresh in our memories. Its brightness, its colour, and its spectrum have been watched with assiduous care throughout its short life, and a large collection of spectrographic plates preserve the record of surprising changes in the structure of its light beams, for the study of the future. The question now is, what has been learned so far from this apparition in Perseus?

Can it be, in miniature, the life-history of a fixed star, of unnumbered ages enacted in the brief span of a few months? Not, certainly, in relation to its birth and growth; but in its decline the Nova might have been expected to exhibit the stages of a star cooling. The loss of heat, whether in ages or in months, should pass through the same degrees of temperature; and the successive spectra of Nova Persei between February 22-23, when the star was at its greatest splendour, and September 5, when it had fallen to near the seventh magnitude, should have become the guiding signs for the classification of stars on the descending scale of temperature. But the changes have been too rapid; the process of ages has been rushed through in hours rather than in months; and no one knows what has been hidden from us in the day-light hours and by the evening clouds of February 24.

On February 22 the spectrum of the star was found, at Harvard College in America, to be of the Orion type, with the first glimmer of bright radiation at the red side edges of the hydrogen lines. On February 23, at the same observatory, a faint photograph "showed no marked change, except that the line K was present." * On the same date at Edinburgh the visual spectrum was described as "a distinct but feebly developed solar type"; † and on the Potsdam plates the 9 hydrogen lines, from $H\beta$ to $H\kappa$ appeared as "broad absorption bands, very weak, diffuse, and only recognisable with difficulty." ‡

On February 24 a great change in the spectrum was found on the photographs at Harvard College, and at the Yerkes Observatory. "It was traversed by numerous bright and dark bands, and closely resembled that of Nova Aurigae." §

Thus in the short space of 48 hours the star's spectrum had changed from that of a white star of the Orion type to a composite spectrum of bright and dark lines: a change to be worked out on a fixed star in ages of time! The intermediate changes are not so

* Ap. J., XIII., 172.
† Edinburgh Circular, No. 54.
‡ Vogel, Ap. J., 218.
§ Pickering, Ap. J., XIII., 172.

clearly known as could be wished; but they are not entirely lost. On the Harvard photographs of the 22nd the bright lines were beginning to appear; but on the Potsdam plates of the 23rd "there was not any suggestion of emission lines or bands,"|| but the hydrogen lines were broad, weak, and diffusive. From this it would appear that on the night of the 23rd the dark hydrogen lines were widened out together with the bright lines, partly masking one another, and extinguishing the bright edges seen on the Harvard College plates of the 22nd. The two series were not yet separated, and the separation took place between the nights of the 23rd and 24th. And if this separation of the bright and dark hydrogen lines is to be attributed to velocities on Doppler's principle, and according to Lord Kelvin's explanation of the high velocity of the cooler gases after impact,¶ the actual collision of the two masses must have occurred between these two nights. Such an occurrence is not inconsistent with the previous short history of the star. It was increasing in brightness from the early morning of February 22, civil time, up to the night of the 23rd, and may have reached its maximum on the 24th in the day-light hours of both Europe and America. During the two or three days of approaching one another, both bodies would suffer tidal disturbances enough to account for the increasing white heat, and brilliant continuous spectrum. And after the crash, the temperature would rise suddenly, vaporising the masses and converting much of the continuous spectrum into gaseous radiations, with corresponding fall off in general brilliancy.

But, to return to the first enquiry, the evidence of the photographic plates of the 22nd and 23rd appears to be against any transition of the spectrum through the changes which are supposed to mark epochs in the long history of the declining life of a permanent star. The transition from the type of the Orion stars to the composite bright and dark broad line spectrum was abrupt; the bright lines had already begun to appear on the 22nd, and the dark lines were broad on the 23rd. It should, therefore, be considered possible that a star of the Orion type might die out without passing through the gradations of the Solar type, unless the gap in the succession of spectra of the Nova was covered by the leap of temperature at the impact of two stars, already suggested. After the first flash of brilliancy the hotter gaseous radiation would be less luminous than that of the previous solid or liquid state, and the scattered fragments would cool down rapidly by freer radiation into space. The pair of stars would be broken up to begin again their slow career of condensation.

The new composite spectrum of February 24, which may be called the second spectrum, to distinguish it from later forms, remained substantially the same until March 19, and is illustrated by the first four photographs of the plate. But one very significant change was in progress during this time, and was completed between March 21 and 22: the dark hydrogen lines were thinning away, and were seen for the last time on March 21. The importance of this lies in its connection with Lord Kelvin's explanation of the *approaching* velocity of the *absorbing* hydrogen. This temporary atmosphere might be very dense at first, forming broad absorption lines, and would thin away in its flight from the star, showing thinner lines and finally vanishing. So that if the dark hydrogen lines had not thinned and disappeared comparatively soon, the chief support of the impact hypothesis would have broken down.

On March 19 another great change was found in the spectrum photographed at Harvard College. This is the third spectrum of the star. It was photographed again at Stonyhurst on the 22nd, 25th, and 28th, and also at the Yerkes Observatory on the 22nd and 28th. But it was not a permanent change. The second spectrum returned on the 21st, 26th, and 27th; and up to April 26 the spectrum alternated between the two forms. The later, or third spectrum, is illustrated on the plate already referred to in the photographs of March 25 and 28. Its leading features are (1) a great apparent extension of the first ultra violet hydrogen line, $H\zeta$, on the side of shorter wave lengths, occupying nearly the whole interval between $H\zeta$ and $H\eta$; (2) the greater prominence of the blue bands, together with new formations between $H\beta$ and $H\gamma$; and (3) the loss of light in the continuous spectrum.

At first these alternations appeared to be connected with the phases of the star's light curve, which at this time were quite periodic, the minimum recurring on the 19th, 22nd, 25th, and 28th. But this three-day period failed early in April; and since then, a comparison of all the photographs taken at Stonyhurst, up to April 26, with the magnitudes of the star as measured at the Radcliffe Observatory, Oxford, has shown that the connection was not with any phase of the light variations, but with an absolute magnitude of the star. All the spectra of the third form appeared when the magnitude of the star was below 4.57; all the returns of the second spectrum occurred when the star was brighter; and on April 9, when the magnitude was at this critical figure, the spectrum had been already noted as belonging partly to both forms.**

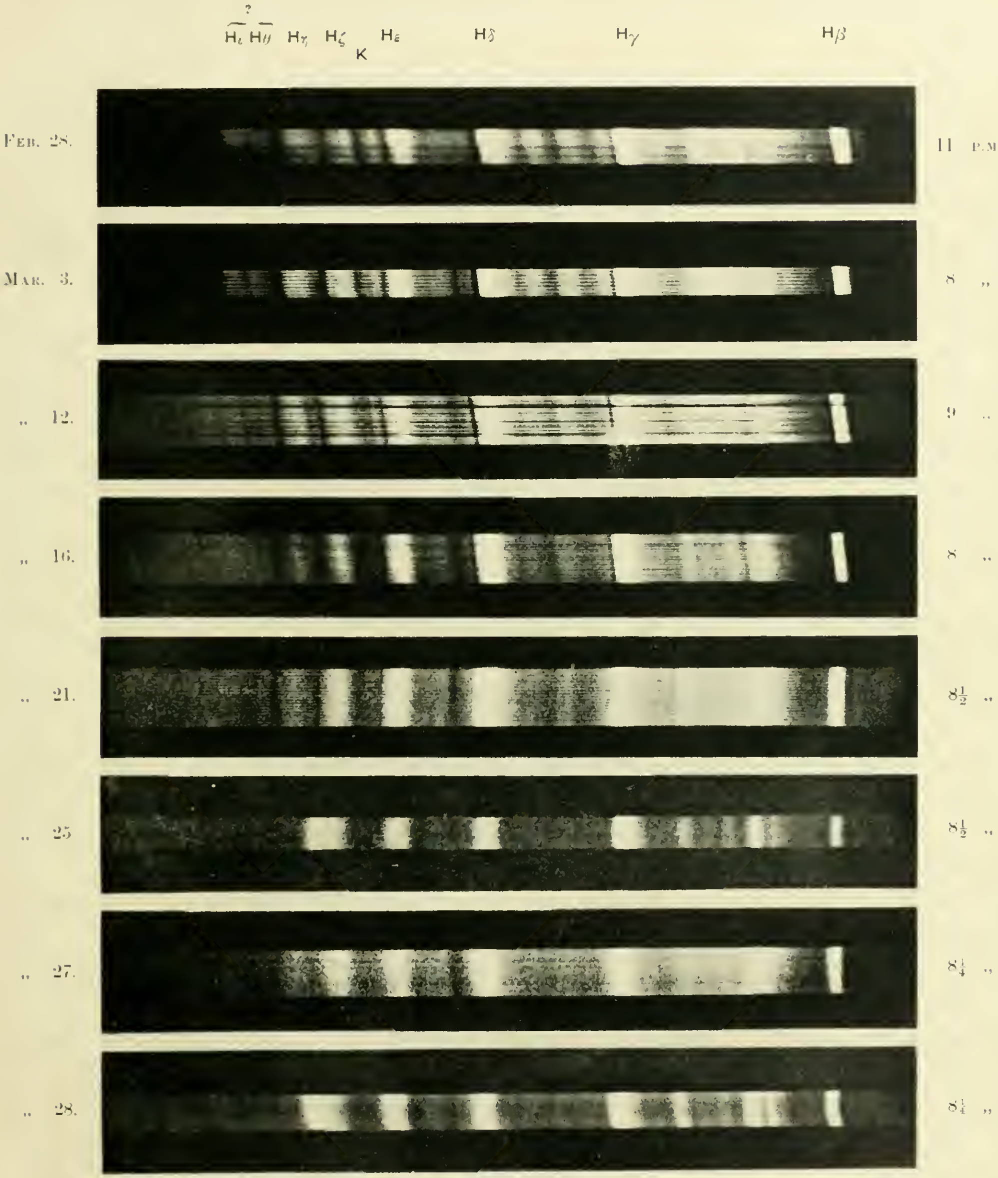
The inference here is that at this period, when the star was largely a glowing gaseous mass, the temperature was oscillating with oscillations of the gaseous volume. This volume of mixed heated gases might well have been put into a state of great oscillation on being set free at the impact of two stars, expanding and contracting, chilling and heating; and when the mean temperature had fallen to the combining temperature of the constituents of the new band adjoining $H\zeta$, this band would reappear and disappear with the oscillations synchronously with the light variations.

So far, therefore, there does not appear to be any insuperable obstacle in the way of the direct collision hypothesis. And the recent astonishing information from America regarding the surroundings of Nova Persei seems to demand the greatest imaginable catastrophe, and there is none greater than the clash of two cold worlds. In these surroundings there is telescopic evidence of matter drifting at a rate which leaves the alarming velocities revealed by the spectroscope to be reckoned amongst comparatively easy going speeds. And the evidence seems to be complete, in the agreement of four separate condensations of nebulosity. The positions of these on a photographic plate exposed on November 7 at the Lick Observatory, compared with a photograph at the Yerkes Observatory on September 20, show practically the same displacements of each, amounting

|| Vogel, *ibid.* ¶ Observatory, No. 306, June, p. 223.

** These comparisons are confirmed by those of Harvard College, in Ap. J., 1901, July, with one exception, viz., that "on April 12 and 13 the magnitude was the same while the spectrum was different." But the Oxford measures give different magnitudes for the two nights, viz., 4.67 on the 12th, when the third spectrum was photographed, and 4.49 on the 13th.—M. N., May, 468.

PHOTOGRAPHS OF THE SPECTRUM OF NOVA PERSEI, 1901.



Stonyhurst College Observatory.

to 1½′ in seven weeks, or 11′ annual proper motion††; and this at a distance no greater than that of the nearest fixed star means a velocity of 2690 miles in the second.

But difficulties begin with the persisting width of the bright hydrogen lines. Unlike their dark companions, these remained strong and broad to the end of April, and again from August 24 to November 28 they were, still, as broad as they were in the middle of April, but no longer the strong lines of the spectrum. For nine full months they have remained abnormally broad; and, since April 16, they have retained constant widths, as compact bands without their hazy edges.

A line may be widened by pressure of the radiating gas, or by the two-way displacements effected by rotating velocities about an axis at right angles to our sight-line. It is not easy to conceive the physical conditions of a star, in which the whirling velocities of the heated hydrogen atmosphere could be maintained practically constant for nine months. Pressure, on the other hand, only requires the central mass to be great enough; but the greatness is too great to be easily accepted; and the compact appearance of the lines is not an expected result of pressure, which hardly admits of uniform density with sharp edges. The difficulty is great; but it does not threaten one more than another hypothesis concerning the origin of the new star in Perseus. It seems rather to be a sign of new discoveries in the spectrum of hydrogen to be expected before any safe conclusion can be drawn about the physical condition of the star; and other peculiarities of the fourth spectrum point the same way.

The fourth spectrum was not photographed at Stonyhurst until August 24.

All the lines of this spectrum agree, in positions, with those observed in gaseous nebulæ. But they are all too broad, and four of them, 3869, 3969, 4363, and 4719, are composite bands, the first three of four components, and the fourth of three.

But apart from the question of the nebulous character of the star, the peculiarities of this spectrum are to us at present an enigma, of which the key-word is probably the line 3969. This line began to put on its present disguise at a rather later stage of cooling than its companion line 3869, at a temperature corresponding with the magnitude 5.3, by appearing in greater strength than the hydrogen line Hδ on April 16. If it is the hydrogen line Hϵ, what condition of glowing hydrogen is indicated by this line being now stronger than all the rest taken together, when usually it is the weakest of those present in the photographs? It might be the calcium line known as Fraunhofer's H in the Solar spectrum; and if so, under what conditions can the calcium H glow strongly without its inseparable and stronger companion K? It might be the helium line 3965 greatly widened towards the red side. Three helium lines could then be counted in the spectrum 3868, 3965, and 4713, the two latter similarly widened so much to the red side as to show the apparent centres of the bands at 3969 and 4719; and all three are composite bands. But why are these the selected lines, or why are the stronger ones absent?

The answers to these queries, when found, will define securely the physical condition of the star, at a time when its spectrum looks so like and yet so unlike that of a gaseous nebula.

†† Lick Obs. Bulletin, No. 10.

Letters.

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

NOVA PERSEI.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The interesting note by M. Antoniadi on the photographic image of Nova Persei is quite in accord with exposures I have made with a portrait lens by Ross. I find the second aureola, which is shown when the exposure has lasted 3½ hours, seems to be about 2½ times further off the central dot than the first aureola, the latter being well shown with an exposure of only ten minutes. If a part of the object-glass is covered the portion of the image on the same side of the disc is missing. This effect can also be seen in other stars, especially those whose photographic image is larger than would be expected from their visual brightness, like δ Persei. If, now, the plate is withdrawn outside the main focus, say, for about $\frac{10}{64}$ in., the images of most stars will be nearly doubled in size, and will have a central dot surrounded by a penumbra equally darkened to the outer edge, but the image of the *Nova* will be nearly of the same size as at the principal focus of the lens, and will be made up of a central dot with a ring round it and the space between only lightly discoloured. This effect is more visible perhaps when part of the aperture is covered, when the central dot and part of the ring do not appear connected. The plate being so far behind the focal plane it will be seen that the part of the image obliterated by partly covering the object-glass is the opposite side, not the same one as in the chief focus. It seems as if there should be two bands in the spectrum beyond the part which causes the central dot, the second one being two or three times further off and of a weaker photographic effect. The spectra shown at the last meeting of the R. A. S., if I remember right, consisted of the nebulous bands and two bright thick lines high up in the violet, of which the second or further one was the brightest, and, moreover, both bands were nearer together than to the main part of the spectrum, which does not seem to correspond to the size of image obtained with a portrait lens.

Inglefield, Little Heath, Potters Bar. Henry Ellis.
24th November, 1901.

RAINBOW BEFORE SUNRISE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—On the morning of Thursday, 21st November, I noticed gorgeous colouring in the south-east part of the heavens, preparatory to sunrise. Near the horizon the sky was comparatively clear, but higher up was a large patch of cloud, tinted brilliantly with red and orange, the intervening spaces being blue with shades of green. There was at the same time a shower of rain advancing from the west, which caught the bright light reflected from the cloud, with the result that a purple rainbow became visible. The time of sunrise for this day is 7.29, and the rainbow was visible from 7.15 (or possibly sooner) to 7.30, when it began to fade away; before 8 o'clock rain was falling overhead. The bow was of very large dimensions, with its two extremities at right angles to the horizon. I should be very much interested to know whether any of your readers have a record of a similar rainbow before sunrise.

E. W. Johnson.

50, Birdhurst Road, South Croydon,
30th November, 1901.

Notices of Books.

"ANIMAL LIFE: A FIRST BOOK ON ZOOLOGY." By David Starr Jordan, PH.D., LL.D., and Vernon L. Kellog, M.S. (Henry Kimpton.) 1901. Pp. ix. and 328. 7s. 6d. net.—This is an exceedingly interesting volume, covering the whole field of bionomics, or, as the authors prefer to call it, "animal ecology." They "have tried to put into simple form the principal facts and approved hypotheses upon which the modern conceptions of animal life are based." Although superficial in character, as may be gathered from its size, the work is nevertheless very successful. Darwinian rather than Lamarckian principles are inculcated, though no direct attention is drawn to the tenets of either school of thought, and this, remembering the nature of the work, is as it should be.

The illustrations, 180 in all, are exceptionally good and well produced. At the end of the book a classification of animals is given, which is undoubtedly useful, but most certainly marred by all disregard for order and method in the arrangement of the examples selected to represent each class. Genera and species from numerous orders are jumbled hopelessly together in one chaotic muddle, thus in Class VI., Mammalia, we have the following:—". . . . Monotremes, monkey, gopher, elk, bison, prairie-dog, big-horn, hare . . . ." and so on. Surely this chapter needs revision!

"OBSERVATION WITHOUT INSTRUMENTS: Hints for Young Watchers of the Heavens." By Arthur Mee, F.R.A.S. (Cardiff: Lennox Brothers.) 1901. Threepence.—Mr. Mee is already well known for his "Observational Astronomy," a marvel of cheapness, and of useful information, well and clearly put, and we feel sure that the reputation he so justly gained by his larger book will secure a very wide circulation for this admirable little tract. It is just the book that thousands of people need, who would like to do something in astronomy and yet cannot afford the money which good instruments, even small ones, cost. Such will find Mr. Mee's neat little pamphlet an introduction to an unsuspected pleasure.

"THE GROWTH OF OUR EMPIRE: A HANDBOOK TO THE HISTORY OF GREATER BRITAIN." By Arthur W. Jose. (John Murray.) 6s.—Accepting the author's own designation of his work as a "Handbook" to the History of Greater Britain, we can commend this volume as a thoroughly readable narrative of the great achievements of the Anglo-Saxon race in every part of the world. And if we regret the inability of a careful and animated writer to distinguish between the partisan and the historian, especially in regard to events passing before his own eyes, it is consolatory to remember that he errs in good company, and that writers of fiction have seldom equalled and never surpassed the prolific imagination of some historians. But some of Mr. Jose's speculations are very thin, and his conclusions, shall we say, deplorable. The history of this great subject has yet to be written, and we may hope that Mr. Jose's Handbook may serve the eminently useful purpose of pointing the way to the greater task. The present book contains many maps well illustrating its subject, and is furnished with a good index.

"PLEASURES OF THE TELESCOPE." An illustrated guide for amateur astronomers, and a popular description of the chief wonders of the heavens for general readers. By Garrett P. Serviss. (Hirschfeld Brothers.) Illustrated. 6s. net.—The title is singularly appropriate. It has evidently been a great pleasure to Mr. Serviss to write the description of all that can be seen, or found out, in the wonder-world that a 5-inch telescope reveals; it is certainly a very great pleasure to read it. We may say that it actually raises a feeling of envy of those who have the opportunity of examining these objects in Mr. Serviss's telescope under his personal direction. The first chapter is not the least interesting, dealing with the selection and testing of a glass. Briefly, Mr. Serviss advises the purchaser to put all his money in the glass, to have the mounting solid, however rough it may be, to carry the telescope tube indoors when not in use (a 5-inch telescope tube and glass would certainly tend to develop one's muscles), and leave "observatory, dome, draughts and all" to those who "are both fond of and able to procure luxuries." Having got the glass, he gives most practical and practicable advice as to how to learn whether any defect in the star image is due to the eye, the eyepiece, the object-glass, or its collimation. Most of the succeeding chapters tell of the double stars, variables, clusters, and nebulæ, which a 3, 4, or 5-inch telescope may be able to show in the constellations. He then describes scenes on the planets, the moon and the sun, and his final chapter discusses the question as to whether there are planets among the stars. This is evidently a matter in which Mr. Serviss takes a deep interest, and from some chance remarks scattered through the book, one learns that he considers that ours is the best possible planet, situated in the best possible solar system, and that he has a deep sympathy for any inhabitant of any planet that revolves round the sun, either interior or exterior to the earth; and very much more sympathy still for the unhappy denizens of the planets which may owe allegiance to Sirius, or to Arcturus or to any other sun.

"MICROMETRICAL OBSERVATIONS OF THE DOUBLE STARS DISCOVERED AT PULKOWA, MADE WITH THE 36-INCH AND 12-INCH REFRACTORS OF THE LICK OBSERVATORY." By W. J. Hussey. (Publications of the Lick Observatory.) The 15-inch refractor by Merz and Mahler was the largest in the world when it was installed in 1839 in the newly erected Pulkowa Observatory. The director of the observatory, Dr. W. Struve, formulated a programme of work with the meridian circle which should give a catalogue of all stars down to the 7th magnitude between the north pole and 15 degrees south latitude. To learn their approximate places, the 15-inch refractor was used for a survey, and in the course of this a large number of double stars were marked. These doubles, in the beginning of 1898, Mr. Hussey decided to remeasure and discuss, and the present volume is the result. It is issued in the same form, as nearly as possible, as the volume of 1290 stars measured and discovered by Mr. Burnham in Vol. I. of the Yerkes' publications. Besides the measurement and discussion of these stars, which should prove of the greatest value to double star observers, Mr. Hussey reviews in the introduction the history of accidental and systematic personal errors, from the time that Dr. William Struve first suggested their existence, and his son, Otto Struve, tried to evaluate them by artificial means.

"ANNUAL REPORT ON THE STATE OF THE PARIS OBSERVATORY FOR 1900." By M. Loewy.—M. Loewy reports that this year he has begun to publish the "Photographic Catalogue of the Heavens," having issued 11 sheets containing the rectilinear co-ordinates of 16,500 stars. The Photographic Chart has not progressed so satisfactorily; its edition being paralysed by the bankruptcy of one of the two firms which undertake the heliogravure of the plates. The photographic atlas of the moon has been proceeding very satisfactorily under the direction of M. Loewy and M. Puiseux, and at the Paris Exhibition last year, two pictures were shown giving a diameter to the moon of 1.38 metres.

"A TREATISE ON PHOTOGRAPHY." By Sir W. de W. Abney, K.C.B., D.C.L., F.R.S. Tenth edition. (Longmans.) Illustrated. 5s.—Sir William Abney's "Treatise on Photography" is so well known in its previous editions that attention need only be drawn to the additions that he has made in the present issue. He has very carefully and fully described the processes of photo-block printing where the details of the work are not yet kept secret by the firms who use this method, and chapters are also added on the orthochromatic and trichromatic processes. On page 277 there is an interesting little account of the author's experiments in pinhole photography. He points out (as Lord Rayleigh did some years ago) that there is a focus of best definition for each particular aperture of pinhole employed, and he also notes that after the aperture of the pinhole is diminished beyond a certain limit, the image ceases to improve in sharpness, as might be expected, owing to the serious diffraction that takes place. The aperture d in millimetres which he finds to correspond best with the distance f in metres of the hole from the plate, is given by the empirical formula $d = 1{\cdot}25\sqrt{f}$, but this does not take into account the wave-length of the ray of light as it theoretically should. Has Sir William ever tried the effect of coloured screens with a pinhole aperture?

"A CIVILIAN WAR HOSPITAL." By the Professional Staff: Drs. A. A. Bowley, H. H. Tooth, C. Wallace, J. E. Calverley, and Surgeon-Major Kilkelly. With numerous illustrations. (John Murray.) 12s. net.—From the point of view of military medicine and surgery, the unfortunate war in South Africa has been of great value; for it has afforded an opportunity of obtaining information with regard to the injuries caused by small-bore, high-velocity projectiles, and the causes of enteric diseases. In this volume we have an account of the work of the Portland Hospital, and of experience of wounds and sickness, with a description of the equipment, cost, and management of a civilian hospital in the time of war. From the large amount of valuable material thus made available, a few points of general scientific interest may be selected. Remembering the established connection between mosquitoes and malaria, and how plague is probably spread by the bites of fleas which have lived on rats stricken with the disease, the observation that flies were always numerous in places where enteric fever prevailed is suggestive. There seems little doubt that flies were to a large extent responsible for the spread of typhoid, though the exact nature of the connection between the insect and the disease has not been made out. We read, for instance, "Flies seem to have a special attraction to enteric fever patients. In a tent full of men, all apparently equally ill, one may almost pick out the enteric cases by the masses of flies that they attract." But this is probably only one means of spreading the disease, and so little is known upon the whole subject that no definite conclusions can be drawn which would permit a scheme of preventive measures to be defined. In the present state of knowledge, it seems to be almost impossible to combat hygienically the spread of enteric in any army under conditions similar to those prevailing in South Africa. Inoculation was tried as a means of prevention, and the results obtained were decidedly in favour of it; but the number of cases was too small to justify any general adoption of the method. Another matter to which one naturally turns is the use of Röntgen rays in locating bullets and determining the nature of injuries to bones. It is admitted that the usefulness of the Portland Hospital would have been impaired considerably if the Röntgen ray apparatus had not been taken out. Simple observation with the fluorescent screen did not prove of much use, but photographs were found of extreme service, and a number of them serve to illustrate the volume under notice. Before the war, little was known as to the effects of high-velocity projectiles on bones, but the Röntgen-ray photographs have enabled surgeons to speak with tolerable assurance on what was formerly mainly speculative. The surgical side of the war is, in fact, much more satisfactory to contemplate than the medical. Of the 303 surgical cases admitted into the Portland Hospital, only three died. Nearly all the wounds healed without suppuration, and there were no cases of erysipelas or other forms of blood poisoning. On the medical side we have the fact that there were 29 deaths in 232 cases of enteric fever, and even this death rate was low in comparison with that of other hospitals. Had it not been for this scourge, the medical casualties of the campaign would have been comparatively insignificant. Let us hope that the materials for the study of the fever afforded by volumes such as the one before us will lead to the development of means for the prevention and cure of the disease.

"THE STORY OF FISH LIFE." By W. Pycraft. (Newnes.) Illustrated. 1s.—In this little work—a companion to "Bird Life"—the author endeavours to interest non-scientific readers in the structure, habits, and evolution of fishes; and, on the whole, we think he may be said to have been fairly successful in a by no means easy task. Commencing with the earliest known types of fishes, the reader is shown how there has been a gradual modification and advance towards the modern forms; special interest attaching to the account of the mode in which the fins of ordinary fishes have been derived from primitive expansions, or flanges, running the whole length of the body. The sentence (p. 10) "that the various kinds of mud with their peculiar fossils represent different periods of time of great duration," is, however, calculated to give the beginner a very erroneous impression as to the mineral constitution of rocks in general. Were we disposed to be severely critical we might also comment on the construction of many of the author's sentences; and we may add that some of the chapter headings are not to our liking, while it is new to us to hear an article of diet spoken of as a "familiar little friend" (p. 187). Nevertheless, Mr. Pycraft has furnished the public with a very readable and interesting "booklet," although his efforts have scarcely been well backed up by his artist.

"THE PLAY OF MAN." By Prof. Karl Groos. Translated by Elizabeth L. Baldwin, with a preface by Prof. J. Mark Baldwin. (Heinemann.)—There is scarcely a page of this book without some facts, observations, or conclusions of interest to students of human activities. The book contains an organised account of games of all kinds, drawn from many sources, and arranged so as to exhibit their scientific significance. In a volume published about three years ago, the play of animals was analysed in a similar way, and the general conclusions arrived at in both books are the same. The view that play represents an overflow of energy is shown to be insufficient, and also the other physiological idea, namely, that play merely represents recreation for exhausted powers. As in the book on the play of animals the conclusion seems to be that instinct is the foundation of play. The exact position Prof. Groos takes may be understood from the following explanation. "Play is the agency employed to develop crude powers and prepare them for life's uses, and from our biological standpoint we can say from the moment when the intellectual development of a species becomes more useful in the struggle for life than the most perfect instinct, will natural selection favour those individuals in whom the less elaborated faculties have more chance of being worked out by practice under the protection of parents—that is to say, those individuals that play. Play depends, then, first of all on the elaboration of immature capacities to full equality with perfected instinct, and secondly on the evolution of hereditary qualities to a degree far transcending this, to a state of adaptability and versatility surpassing the most perfect instinct." The last part of the book contains a philosophical examination of play from the points of view of physiology, biology, psychology, æsthetics, sociology, and pedagogy; and the whole work may be described as an interesting history of play with an attempt to find a reason for play phenomena. The translation reads fluently and is an excellent piece of work.

"PRACTICAL HISTOLOGY." By J. N. Langley, M.A., D.SC., F.R.S. (Macmillan.) 6s.—Histology, or the study of the minute structure of tissues, is a large and difficult subject, and a book which facilitates the work of students by giving concise and precise directions for experiments and observations is sure of an appreciative public. The book under notice belongs to this class. The preparation and methods of examination described are well selected and practical; the directions are sufficient, and with reasonable care instructive results can be obtained. The student of biology is, in fact, lead by plain paths to distinguish the structure, nature and properties of the various tissues of the animal body. The first chapter is concerned with the microscope and its use, and is followed by chapters containing directions for simple observation on the blood and lymph. Instructions are then given for staining, mounting, and other processes connected with the preparation of sections, after which follow twenty-eight chapters each containing experiments and demonstrations on the differentiated and undifferentiated cells which are built up into the organs of the body. To the naturalist who delights in animate nature this resolution of body substance into its ultimate elements has little interest, but to the student of physiology it is essential; and it is to these students that the volume will prove of service.

BOOKS RECEIVED.

The Earth's Beginning. By Sir Robert Stawell Ball, LL.D., F.R.S. (Cassell.) Illustrated. 7s. 6d.

The Sacred Beetle: A Popular Treatise on Egyptian Scarabs in Art and History. By John Ward, F.S.A. (Murray.) Illustrated. 10s. 6d. net.

The Stars: A Study of the Universe. (Progressive Science Series.) By Simon Newcomb (Murray.) 6s.

Text-book of Zoology. By G. P. Mudge, A.R.C.SC. (LOND.), F.Z.S. (Arnold.) Illustrated. 7s. 6d.

Wales (The Story of the Nations). By Owen M. Edwards. (Unwin.) Illustrated. 5s.

Chess Player's Note Book. By Rhodes Marriott. (Manchester: Sherratt & Hughes.) 1s.

Official Year-Book of the Scientific and Learned Societies of Great Britain and Ireland, 1901. (Griffin & Co.) 7s. 6d.

History and Chronology of the Myth-making Age. By J. F. Hewitt. (Parker & Co.) 15s. net.

Process Year-Book, 1901. Edited by W. Gamble. (Penrose.) 3s. 6d.

Moral Nerve and the Error of Literary Verdicts. By Furneaux Jordan, F.R.C.S (Kegan Paul) 3s. 6d. net.

Whitaker's Almanack, 1902. 2s. 6d. net.

British History made Interesting. By C. V. Hartley. (Simpkin.)

Origin of Species. By Charles Darwin. (Murray.) 1s net.

International Annual of Anthony's Photographic Bulletin, 1902. (Iliffe.) 2s. net.

Current Papers, No. 5 (Reprinted Proceedings of the Royal Society of New South Wales). By H. C. Russell, B.A., C.M.G., F.R.S.

Treatise on "Levity" in its Relation to "Gravity." By Jas. H. Shaw. (Scientific Press.) 6d.

Nautical Astronomy. By J. H. Colvin, B.A. (Spon.) 2s. 6d. net

Origin of Species. By Charles Darwin. (Ward, Lock.) Illustrated. 2s.

Elements of Botany. By W. J. Browne, M.A. (LOND.), M.R.I.A. (John Heywood.) Illustrated. 2s. 6d.

Annual Report of the Board of Regents of the Smithsonian Institution for the Year ending June 30th, 1900. (Washington: Government Printing Office.)

Practical Radiography. By A. W. Isenthal, F.R.P.S., and H. Snowden Ward, F.R.P.S. (Dawbarn & Ward.) Illustrated. 6s. net.

Commercial Geography of Foreign Nations. By F. C. Boon, B.A. (LOND.). (Methuen.) 2s.

Geographical Teacher, October, 1901. (Geo. Philip & Son.) 1s net.

City and Guilds of London Institute. Report on the Work of the Examination Department for 1900-1. (Whittaker.) 9d. net.

Research in the Scottish Universities. By James Gordon Macgregor, D.SC, LL.D., F.R.S. (Edinburgh: James Thin.)

NOTES.

Astronomical.—Several attempts have been made to ascertain the date of the original construction of Stonehenge from astronomical considerations, but hitherto the adopted data appear to have lacked the precision which is necessary in calculations depending upon the secular variation of the obliquity of the ecliptic. There is every indication that one use of the structure was to mark the direction of sunrise at the summer solstice, and it is evident that if this direction can be determined the departure from it of the present point of sunrise will furnish material for an estimation of the date. In a paper recently communicated to the Royal Society, Sir Norman Lockyer and Mr. F. C. Penrose give particulars of observations made last year which have led them to fix the date at about 1680 B.C. The adopted azimuth of the axis is 49° 34′ 18″, and the elevation of the local horizon 35′ 30″; it has further been supposed that the sun's upper limb was 2′ above the horizon when the observations were made, this estimate being based upon an actual observation of sunrise made on June 25th. It is notable that implements which have been discovered since the above observations were made also indicate a fairly accordant date.

The probability that the solar corona consists largely of particles capable of reflecting the light of the photosphere has been greatly strengthened by the observations of the eclipse of last May. The evidence of polarisation obtained by Mr. Newall has been fully confirmed by the work of the party from the Lick Observatory, and the Lick observers have also established the presence of Fraunhofer lines in the spectrum of the outer corona by using instruments of low dispersion. The continuous spectrum of the inner corona is readily accounted for by supposing the particles to be incandescent in the immediate neighbourhood of the photosphere. It therefore seems reasonable to suppose that the coronal streamers consist of finely-divided particles of matter ejected with great velocity from the surface of the sun. The observations of all the eclipses since 1893 indicate that the part of the corona giving a gaseous spectrum is relatively very shallow.

Further details given in Lick Observatory Bulletin No. 10 appear to leave little doubt as to the reality of the enormous proper motion of four condensations in the nebula surrounding Nova Persei. The result was arrived at by comparing a photograph taken on November 7th with one taken 48 days earlier at the Yerkes Observatory, from which it appears that the movement is at the rate of 11′ a year, and is certainly not radial. It is probable that the nebula is intimately connected with the Nova, and it does not seem unlikely that a study of their relationships will throw much light on the origin of new stars.—A. F.

Botanical.—The function of crystals of calcium oxalate in plants is discussed in the current volume of the *Botanical Gazette* by Dr. A. Schneider. The commonly accepted theory is that these crystals protect the plant against herbivorous animals, either in consequence of an unpalatable taste which they are supposed to impart to the herbage, or of mechanical interference. It is shown that calcium oxalate is dissolved with difficulty, being insoluble in water, alcohol, ether, acetic acid, saliva, and other animal secretions, and is, in these substances, tasteless. It is therefore inferred that taste does not repel animals. Protection by mechanical means is thought to be improbable from the way in which the crystals are distributed through plant-tissues. Instead of being confined to peripheral parts, where their effects would be most pronounced, they are often abundant in the pith and heartwood of stems. Kraus in 1891 suggested that calcium oxalate was a reserve product, which would be re-dissolved and again utilised by the plant. This, Dr. Schneider believes, is its secondary function, the primary one being that of mechanical support as exemplified in parts of certain plants where sclerenchymatous tissue is replaced by crystal-bearing cells.

In the *Indian Forester* for October, 1901, Sir Dietrich Brandis draws attention to two Burmese aromatic woods, one of which (*Cordia fragrantissima*) is the source of a cosmetic and perfume used by Burmese ladies. It has a brown, very hard heartwood, which is strongly aromatic, differing in this respect from that of allied species, in one of which, however, it is slightly scented. The other wood is produced by a close ally of *Santalum album*, the sandal-wood tree, but differs in having longer medullary rays and a dark olive-brown heartwood.—S. A. S.

Zoological.—So far as mammals are concerned, the most important event we have to chronicle is the arrival at the Duke of Bedford's park, Woburn Abbey, of a drove of Przewalski's horse (*Equus przewalskii*), from the deserts of Mongolia. Although this species was described twenty years ago, no specimen has hitherto reached England, and naturalists have been very imperfectly acquainted with its affinities, and have had doubts whether it was really entitled to rank as a species. In spite of being colts, the specimens at Woburn Abbey demonstrate the distinctness of this most interesting member of the equine family, and show that it is more nearly related to the horse than to the wild asses, although presenting some resemblance to the latter. In general appearance the colts are not unlike New Forest ponies, although their white muzzles give them a somewhat asinine appearance. They are dun-coloured, with black points, and show in most cases no dark stripe down the back. They have, like the horse, "chestnuts" on all four legs; but the long hairs on the tail do not commence quite so high up as in that species.

Dr. A. Nehring, of Berlin, has recently described (in *Globus*) the skull of a large fossil camel from Russia, which he believes to be the ancestor of the living two-humped Bactrian species. These two species appear, indeed, to be natives of Central and Northern Asia, and are essentially adapted for a cold climate. The one-humped Arabian camel, on the other hand, seems to have originated in tropical or subtropical regions.

American naturalists are devoting much attention to the restoration of the external bodily form of extinct animals; and in the Smithsonian Report for 1900 Mr. F. A. Lucas, of the U. S. National Museum, has published an interesting paper dealing with the history of the subject. The attempts at restoration by Cuvier in Paris and Waterhouse Hawkins at the Crystal Palace, together with others, are each in turn referred to. The author then describes in considerable detail modern American methods of arriving at an opinion as to what an extinct animal really looked like when in the flesh. "While the restoration of extinct animals," he observes, "is subject to some uncertainties, and mistakes of interpretation are likely to occur, these efforts to reproduce the living forms of past ages are not mere guess-work, but rest upon a solid foundation of scientific facts and careful deductions." One great difficulty is that the skeleton gives no clue to many external peculiarities. For instance, we could not tell from their bony framework that the African rhinoceroses have a smooth skin, while in the Asiatic species it is thrown into great folds. In some cases, therefore, it is almost certain that the restorations cannot be exactly true to nature. Nevertheless, the work deserves every encouragement, and cannot fail to add to the popular interest in extinct animals.

At a recent meeting of the Zoological Society, Mr. O. Thomas, of the British Museum, gave an account of the specimens of the "five-horned" giraffe brought home by Sir Harry Johnston from the neighbourhood of Mount Elgon, in the Uganda Protectorate. In spite of the unusually strong development of the horns, these specimens were referred to the typical North African giraffe, which appears to pass gradually into the giraffe of South Africa. The Somali giraffe, on the other hand, of which fine specimens were obtained by Lord Delamere during his expedition to North-eastern Africa, is a distinct species, which must be known as *Giraffa reticulata*. With regard to the two posterior rudimentary horns, to which attention was first directed by Sir Harry Johnston, it appears that these exist in all members of the group. They seem to correspond to the large pair of occipital horns which occur in the extinct genus *Bramatherium*, from Perim Island, Gulf of Cambay, and may therefore have been much larger in the giraffe's ancestors.

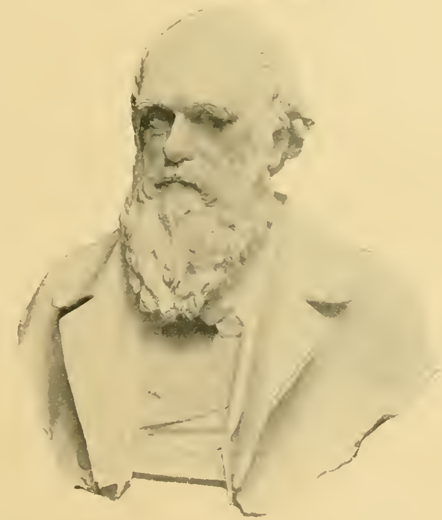
An important monograph on the structure of the skull in the egg-laying (monotreme) mammals, by Professor J. F. van Bemmelen, appears in the Denkschrift of the Jena Society, as one of the contributions to the results of Dr. Semon's recent expedition. The material thus obtained has very largely increased our knowledge of many peculiar types of Australasian animal life.

American naturalists are turning their attention with considerable energy to the animals of the Old World; Mr. G. S. Miller, in the *Proceedings* of the Biological Society of Washington, having recently described three new shrews from Asia and one from Switzerland.

Travelling in the Sudan.—We have received from Captain Stanley S. Flower, the Director of the Sudan Wild Animals Department, a copy of a pamphlet entitled "Notes for Travellers and Sportsmen in the Sudan." The pamphlet is published "by authority," and gives much well-arranged information, which will be found exceedingly useful to those intending to travel and shoot in the Sudan. We note, with pleasure, that the Game Laws have been lately revised, and that the number of animals and birds protected has been increased. It is now illegal to kill or capture the following animals and birds anywhere in the Sudan:—Chimpanzee, Eland, Giraffe, Rhinoceros, Zebra, Wild Ass, Ground Hornbill, Secretary Bird, and Shoe-bill; while in certain districts the Elephant and Hippopotamus are also protected. Many other animals and birds are protected by limiting the number which may be captured or shot. But perhaps the most valuable innovation is the creation of a large Game Reserve, in which only officers of the Egyptian Army and of the British detachment at Khartoum and officials of the Sudan Government have the privilege of shooting. This reserve will thus form practically a sanctuary.

The Rev. H. A. Macpherson.

We much regret to have to record the death of the Rev. H. A. Macpherson, which took place at Pitlochry in November last. As a naturalist, and especially as an ornithologist, Mr. Macpherson was well known. He was a native of Skye, and was for some years chaplain of Carlisle Gaol; while in 1897 he was nominated to the perpetual curacy of Allonby, and was incumbent of the Episcopal Church of Pitlochry. During his residence in Cumberland he published a book in collaboration with Mr. Duckworth on the birds of that county, and an important volume on the Fauna of Lakeland. He was also the author of the "History of Fowling," while he contributed to the volumes on the "Grouse" and the "Partridge" in the Fur and Feather series, and was well known for his many articles and notes appearing from time to time in the *Ibis*, *Zoologist*, *Field*, and other journals. Beyond his literary abilities Mr. Macpherson was an excellent field-naturalist, and his loss will be keenly felt by all ornithologists.



Darwin.

Mr. Horace Montford's new bust of Darwin, made for Mr. Andrew Carnegie.

A Bust of Darwin.—We are enabled to reproduce a photograph of one of the two busts of Darwin for which Mr. Montford, the sculptor of the Shrewsbury statue, has received a commission from Mr. Andrew Carnegie. The busts are cast in bronze and mounted on marble pedestals, and the work is based on the marble bust made by the same sculptor for the late Lord Farrer. One of the busts will be placed in the Pittsburg Museum, and the other will go to Skibo Castle.

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

BAER'S POCHARD (*Nyroca baeri*) IN HERTFORDSHIRE.—At the meeting of the British Ornithologists' Club, held on November 20th, 1901, the Hon. N. Charles Rothschild exhibited a specimen of this Asiatic duck, which had been shot on the Tring Reservoirs, Hertfordshire, on November 5th, 1901. This duck had never before been obtained in the British Islands, and the only question was whether Mr. Rothschild's specimen was a truly wild bird or an escape. The specimen had no appearance of having been in captivity, and Mr. Rothschild had satisfied himself that it had not escaped from the Zoological Gardens, where there are four pinioned birds of this species. The Duke of Bedford and Mr. J. G. Millais, in reply to enquiries, stated that they were not aware of any of these birds having been turned out on artificial waters in this country. So that the evidence so far points to the fact that Mr. Rothschild's specimen is a truly wild bird, which doubtless lost its way and wandered to this country in the same way that other Asiatic birds have done, *e.g.*, MacQueen's Bustard and Radde's Bush Warbler.

CAROLINA CRAKE (*Porzana carolina*) IN TIREE.—At the same meeting as that referred to above, Mr. E. Lort Phillips exhibited a specimen of the American bird, the Carolina Crake, which he had shot in the island of Tiree, on October 25th, 1901. Two other specimens of this species have been recorded as having been obtained in Great Britain.

YELLOW-BILLED CUCKOO (*Coccyzus americanus*) IN SOMERSETSHIRE.—Another American bird, the Yellow-billed Cuckoo, which has occurred several times before in the British Isles, was exhibited by Mr. Robert H. Read. The specimen was obtained at Pylle, near Shepton Mallet, on October 6th, 1901, by Mr. F. Dowling. A discussion on these specimens resulted in the opinion that the birds which visited us from America, and especially insectivorous species such as the Cuckoo, were under the suspicion of having received assistance in crossing the Atlantic by resting upon ships. It had often been observed on Atlantic passages that birds alighted on the vessel near America and rested in the rigging until the ship neared the coast of Ireland, when they flew off to the shore. At the same time it was a fact that American birds almost invariably visited our shores in October during the autumnal migration, which pointed to the conclusion that they had been blown out of their normal course. With a bird such as the Crake, with a strong flight and powers of alighting and resting upon the water, it was possible to understand that it could accomplish the passage of the Atlantic unaided.

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.

STUDIES IN THE BRITISH FLORA.

By R. LLOYD PRAEGER, B.A.

I.—PLANT COLONISTS.

PRIOR to the time when man in these countries began to till the ground—say between 2000 and 5000 B.C.—the face of the land had an aspect very different from what it bears at present. Long before Neolithic man introduced the arts of husbandry, and began to choose pasturage for his flocks and to sow in the ground, in order that he might reap, the land had been completely colonised by plants which are still our common wild-flowers, and every nook and corner had its chosen inhabitants. On the lower grounds, forest trees held sway, and herds of grazing animals roamed through extensive woods. In rougher country great stretches were occupied by trees of lesser stature, and deer and wild boar and wolf found secure retreats among thickets of Oak, Birch, Holly, and Hawthorn, such as still occupy stony slopes in hilly districts. Elsewhere grassy downs extended, and great undrained marshes—secure home of the crane and bittern—while in mountain regions alone the scene was very similar to that which still meets the eye. The vegetation was that which entered or returned to the country at the close of the Glacial Epoch, and which has held sway, except when disturbed by man's operations, ever since. At what period, from what centres, by what means, and in what order our present flora arrived in the country, and what has been its history since its arrival, are questions of deep interest, on which recent researches in our latest geological deposits are casting light. To that subject we may return later; suffice it for our present purpose to find, at the period when man's influence first began to affect the vegetation, the bulk of our present flora firmly established in the country.

When our forefathers commenced to till the ground, a destruction of the native plant associations was the result; and this gave an opening for other plants suited to the new conditions. Annuals could maintain their hold year by year on the tilled land, where the former perennial plant-groups could no longer exist. And clearly those plants whose seeds happened to be mixed with the grain which the early husbandmen sowed, would have an excellent opportunity of survival. Thus we can conceive that the now large and well-marked group of weeds of cultivation had a very early origin. Nor is it impossible to conjecture that in some cases plants originally native may have found a congenial habitat on these prepared grounds, and by degrees forsaken their old haunts and established themselves mainly here, and become parasitic, so to speak, not on man, but on man's operations. Certain it is that we have plants in our flora, which are presumably original natives, yet are always or generally found in association with man (though not of any service to him) in cultivated land or about dwellings,* etc. Pot-herbs and simples were no doubt also of very early introduction, and, planted near the dwellings, in many cases established themselves. In the woodlands and thickets, the influence of man was probably more slow to make itself felt; but the lopping of branches and felling of trees of chosen sorts for the manufacture of utensils and implements, and for firewood, must have by degrees effected the plant associations of the forest; and in later times wholesale clearing of wooded areas for purposes of

* An illustration: What would be the distribution of the Wall Rue or Wall Pellitory if man did not use lime mortar for building?

husbandry banished the sylvan species, and allowed other plants to usurp the ground. And all the time, as trade and intercourse increased, circumstances favoured the introduction of fresh colonists. The growth of towns began to have a local effect on the flora; accumulations of rubbish of all kinds harboured a motley half-alien vegetation, and the fouling of rivers tended to break up the natural plant associations of the waters. The draining of marsh-lands completely altered the flora of large areas; the building of roads and the diverting of streams played their parts both in extermination and introduction. The gratifying of the æsthetic perceptions of the race also by degrees exercised a great influence on the flora, and with the advance of horticulture exotic after exotic escaped from the bounds of cultivation and more or less permanently won a place among the native vegetation. With the growth of modern commerce, and the construction of canals and of railroads, an immense impetus was given to the introduction and dissemination of all kinds of plants; till, in these last days, we deem it a matter of but momentary wonder to find, growing in company with native forms, some flower that has wandered hither from the shores of the Black Sea or the Baltic, from New Jersey or California.

From this brief history it will be seen that the vegetation of our islands, as it now presents itself, is by no means a homogeneous or natural assemblage of plants. The higher regions of the mountains, the large lakes, swamps, and bogs still retain their primitive facies, and there the original flora remains almost unmolested; but as we pass from these waste lands to the inhabited areas, where highly cultivated land is dotted over with towns and villages, and intersected with roads, railways, and canals, a greater and greater number of alien plants put in their appearance, till in waste ground adjoining harbours or mills, we may find a rank flora struggling for existence amid murk and dust, in which exotic plants, the produce of widely separated lands, form the larger portion of the vegetation. To take an instance, the flora of Ireland numbers about 900 undoubtedly native species, to which may be added about 130 others which, though now permanent members of the flora, are considered to be possibly or certainly introduced originally; and about 200 other plants have been found growing spontaneously, which are certainly exotic, and not established. In other words, of this total of 1230 plants, 73 per cent. represent the original vegetation of the country; 10 per cent. we may generally call plants which came with man and have now won a place in the permanent flora; while 17 per cent. represent the waifs and strays brought into the country by trade, agriculture, and horticulture; some of the last will no doubt eventually establish themselves.

We may now consider in greater detail the various groups of which our immigrant vegetation is composed, and dip, where it is possible, into the history of a few of their leading members. If I draw many of my examples from Ireland, it is because the recent publication of "Irish Topographical Botany" brings detailed statistical information concerning the flora up to a later date than is available for England.

First we have the group of crop plants—species which are grown for economic purposes, and which may spread and establish themselves. Some of these are, others may be, original natives; others again are undoubtedly exotic. The Lucerne (*Medicago sativa*), for instance, a native of the eastern Mediterranean, has long been grown as a fodder plant, and has now established itself on banks and dry ground in many places. The Comfrey (*Symphytum officinale*), on the other hand, is undoubtedly native in England, but apparently not so in Scotland or Ireland; yet has been so widely cultivated that its range now extends all over Ireland, and well up into Scotland. The Parsnep (*Pastinaca sativa*) in rank and distribution stands on a very similar footing; it has been in cultivation since Roman times. The Turnip, in its various forms (*Brassica Rapa, Napus campestris*) may be cited as one of the plants whose standing it is now almost impossible to determine. It has been widely cultivated for several thousand years, and is so still, whether as a root crop, for fodder, or for the manufacture of rape or colza oil. Which of the many forms are or were native, and what their distribution was, are questions which cannot now be answered with any degree of satisfaction.

From these crop-plants we turn to the next group—the many unwelcome species which accompany them in tilled ground, and which we call weeds. The typical weeds of cultivation are annual plants with small seeds, and they favour dry soils. Only annual plants (or species with deep-creeping underground stems like the Couch-grass) can maintain their position in tilled land, which each year undergoes a complete turning-over. Their numerous small hard seeds are well calculated to receive a wide scattering by wind or other agencies, to escape the eye of birds and other gleaners, and to endure the severities of the winter. Abundantly sown, they year by year bring forth abundantly. In a field of corn we see these plants at their best. The Poppies *may* be original natives, but we certainly never see their scarlet blossoms in such glorious display as among the corn. The Fumitories belong to the same category. The Corn-Salads are more open to suspicion, except *V. olitoria*, which may be seen far from cultivation; on the basaltic cliffs of Antrim, it forms a close mat in spring with the Mossy Saxifrage, mixed with several species of *Hieracia*. The White Mustard (*Brassica alba*), Wild Radish (*Raphanus Raphanistrum*), *Erysimum cheiranthoides*, the charming Blue-bottle (*Centaurea Cyanus*), the Corn-cockle (*Lychnis Githago*), are confined to cultivated ground, and we assume them to have been introduced with seed. Many of them can maintain themselves year by year if only tillage keep the ground clear of aggressive perennials; but others, like Gold-of-pleasure (*Camelina sativa*), *Saponaria Vaccaria, Silene dichotoma*, etc., though growing luxuriantly when sown with the crop, do not usually appear the following season; perhaps the dampness of our island-winters destroys the seed of these plants of the European continent. Of some of these weeds of cultivation, now abundant, we can approximately date the introduction. *Veronica Buxbaumii*, a plant with a wide distribution on the Eurasian continent, appeared in England about 1825, in Ireland prior to 1845; it is now one of the common weeds of cultivated ground from end to end of these islands. *Veronica peregrina* is an American plant, now widespread over Europe. It appeared in Ireland in 1836, and has colonised garden ground over a large area of the north-west of the island. Of the Lesser Broom-rape (*Orobanche minor*), we read in 1866 that it has been noticed in two clover-fields in Cork, for one season only, having been introduced with the seed; now it occurs over the whole east and south-east of Ireland, from Belfast to Bantry, and in the south-east is permanently established. So with the Clover Dodder (*Cuscuta Trifolii*) in Ireland. In 1866 it "has been observed once or twice in clover fields, but has not become established; its seeds appear to be killed by a severe winter." It is now naturalised in widely separated stations, chiefly in sandy soil near the sea, and is advancing rapidly in some cases into wild ground. Both of the last-mentioned plants are widespread European species, and, as might be expected, they colonised England prior to their invasion of Ireland.

To an allied category belong those plants, not indigenous, which are of casual introduction. That they were not introduced with crops is shown by the fact that their headquarters are not in cultivated land, but in situations of different and various kinds, and often of an artificial character. Seeds of these species have come into the country by one means or other in the course of trade and commerce, and when they have happened to fall on suitable ground, they have formed a colony, and sometimes spread widely. The Lesser Toadflax (*Linaria minor*), a plant of sandy soils, is spread over almost

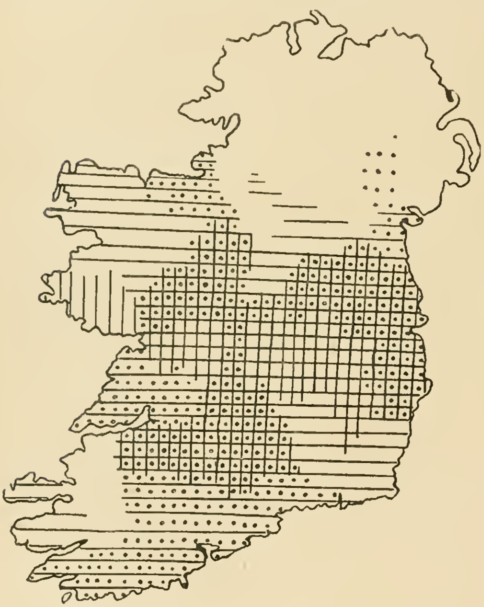


Fig. 1.—Present range of three Irish railway colonists.

═	Linaria minor, first observed about 1819.	
⋮	Diplotaxis muralis, „ „ 1833.	
‖	Arenaria tenuifolia, „ in 1897.	

the whole of Europe, but is not considered native in the British Islands. In Ireland it was introduced early in the nineteenth century. Not finding there the sandy soils which it affects, it invaded the railways, and spreading along the gravelly ballast, has so increased that, excepting the northern counties, it now occurs all over the island. *Arenaria tenuifolia* has a similar history, except that it is native in England on light soils, and was not observed in Ireland till 1897; it is now known to occur, always on railway tracks, in fifteen out of the forty Irish county-divisions. Like the weeds of cultivation, both of these plants are annuals with numerous small seeds, which are easily transported. The most remarkable of recent Irish immigrants is *Matricaria discoidea*, a plant like a Chamomile without ray-florets, and possessing a strong agreeable Chamomile odour. It is a native of North America. First observed near Dublin in 1894, it is now spread, often in immense profusion, on railways, roadsides, and waste ground over the whole of central Ireland, embracing nearly half the country. This is also an annual, producing a great quantity of minute seeds.

The most famous of all our colonising exotics is the Water-Thyme, or Canadian Weed (*Elodea canadensis*), whose dramatic history is well known. Unintentionally introduced from America into Ireland about 1836, and England about 1841, it spread like wildfire through the rivers and canals, threatening to choke the water-ways, and carrying consternation to the hearts of the local authorities responsible for water-traffic and drainage. It has now paused in its wild career, and remains a perennial member of the flora over a great portion of the British Isles. Another American plant, and one whose status is far more difficult to determine, is the Rush, *Juncus tenuis*. During the last forty years this plant has been found in many European countries, and in these islands in Scotland, Wales, S.W. England, and West Ireland, chiefly on roadsides in uncultivated districts near the sea. If it is native, it is hard to credit its being so long undetected; if introduced, the difficulties of accounting for its wide distribution in wild regions, far from centres of dispersal, are equally staggering. It is, naturally, near the centre of trade that foreign immigrants most abound. About docks and railway sidings, flour mills and distilleries, and ballast heaps, we may gather, sometimes by the score, waifs from many parts of the world. Many of these are old acquaintances, loafers in half the seaports of the land; for instance, *Lepidium Draba*, *Erysimum orientale*, *Silene Armeria*; and various species of *Sisymbrium*, *Malva*, *Melilotus*, *Xanthium*, *Echinospermum*, *Bromus*, and so on, drawn from various parts of Europe and America, swell the motley crowd.

The cultivation of pot-herbs and simples, though now almost fallen into disuse, has bequeathed to us a varied and extensive legacy of plants of doubtful standing. The domestic use of many such species in these countries dates back to the Roman occupation, and in early Christian times the spread of monastic establishments distributed medicinal and culinary herbs all over the country, for the monks were skilled in leechcraft and gardening. As in other cases, it is now often difficult to determine in what instances the plants were derived from aboriginal stock, and in what cases they were imported and have since run wild. The great Leek, *Allium Babingtonii*, is widely distributed among native plants along the west coast of Ireland, and grows also in Dorset and Cornwall; yet there appears a strong probability that it is a relic of ancient cultivation. Several other Leeks, and many Mints, have the same story. The Good King Henry (*Chenopodium Bonus-Henricus*), Caraway (*Carum Carui*), and Parsley (*Petroselinum sativum*) are more evidently of cultivated origin, still haunting chiefly the vicinity or sites of dwellings. The noble Elecampane (*Inula Helenium*) was formerly in great repute as a pectoral and stomachic medicine, as witnessed by the old Latin adage—

Enula Campana reddit præcordia sana.

Its candied rootstock is still used as a sweetmeat. A few years ago I came across a colony of this plant which is interesting as showing its early use, and the persistency of its growth. Inismacdara (*the island of the son of Dara*) is a small islet in the Atlantic off the Connemara coast, windswept and uninhabited, and known among archæologists as the site of a very early Christian settlement. Here, in the sixth or seventh century, Saint Sinach MacDara built a tiny oratory, of which the walls, formed of cyclopean masonry, and even portions of the solid stone roof, still remain. That the little colony had not a very long history appears from the fact that no trace of ecclesiastical edifices of later date exists; but that the ruins were respected, and that no house or garden at any subsequent time occupied the site, may be assumed from the reverence in which the memory of the saint, his church, and stone cross are still held—not to mention the remoteness and desolate inhospitableness of the place. Visiting the spot a few years ago, a colony of the Elecampane was observed hard by the church, where, no doubt, the saint had his modest kitchen-garden. Even allowing the establishment to have existed for three or four centuries, a clear thousand years is left during which this plant has maintained its existence. As instances of other cultivated medicinal herbs now widely distributed among the native flora may be mentioned the Horse Radish (*Cochlearia Armoracia*), Gout-weed (*Ægopodium Podagraria*), Alexanders (*Smyrnium Olusatrum*), Sweet Cicely (*Myrrhis odorata*), and Dwarf Elder or Dane's-blood (*Sambucus Ebulus*).

In the same section of the flora we may place a few non-indigenous fruit-trees, now widely spread—the Wild Plum (*Prunus domestica*), Bullace (*P. insititia*), and Dwarf Cherry (*P. Cerasus*); likewise many species of Willow. The Willows have long been planted by river sides, for the purpose of basket-making and as a protection to the banks, and as they are naturally riverside species, much difficulty now arises in discriminating between indigenous and introduced forms.

Lastly, a long list might be compiled of plants which have been introduced into our gardens, shrubberies or lawns for ornamental purposes, and have effected a more or less permanent lodgment beyond the bounds of cultivation. The Wall-flower (*Cheiranthus Cheiri*), Yellow Fumitory (*Corydalis lutea*), Red Valerian (*Centranthus ruber*), and several species of Stonecrop have escaped to walls and rocks, which they brighten with an abundance of brilliant blossoms; all are natives of Europe, but none of Britain. Among shrubs, several of the St. John's-worts, notably the large-flowered *H. calycinum*, a native of S.E. Europe, may be quoted as examples. A remarkable case is that of the Yellow Monkey-flower (*Mimulus guttatus*), a North American native, which has not only spread widely along river-sides, but shows a preference for invading quite wild ground, ascending the streams to their sources among the hills, and ousting the rank native vegetation of the swamps at the river-mouths. The Winter Heliotrope (*Petasites fragrans*), an Italian species, is a relentless invader, before whom most of our woodland plants are as powerless as the Britons before the armour-clad phalanx of Rome. With perennial creeping rootstock and dense foliage which chokes off every other plant, it advances steadily, entirely usurping the ground. And as the fleshiness of its underground stems ensures for it a prolonged vitality, it colonises every garden rubbish-heap in which a scrap of its stems occur. Thus it has attained a wide distribution—in Ireland it is recorded from 34 out of the 40 divisions. Steller's Wormwood (*Artemisia Stelleriana*), a native of distant Kamtschatka, cultivated in gardens on account of its pretty felty grey foliage, has spread to wild sand-dunes on the coasts of the United States, Sweden, and Ireland, among such purely natural surroundings that it has been claimed as a native by botanists of high repute.

Summing up all that has been said, we see how composite a thing our present-day flora is, and how many difficulties the student of geographical botany has to contend with in endeavouring to trace the history of the vegetation of the country. A weed may perhaps be defined as a flower in the wrong place; but in Nature there are no wrong places. Let tillage cease on any portion of the earth's surface, Nature takes it in hand; and through more or less rapid progressive changes of flora, the land is occupied by the plants best fitted to hold it, and the natural equilibrium restored. And while our beautiful aboriginal vegetation has for all scientific minds a surpassing interest, not less interesting is the strangely heterogeneous collection of plants that stand ranged about the works of man. The native flora speaks to us of pre-historic times, and links the present with the past; our "weeds," using the term in a wide sense, are full of human interest, and furnish indeed a floral history of mankind, telling us of his migrations, his early civilisation, his arts and crafts, and his trade-routes by land and sea.

COLLECTING AND PREPARING FORAMINIFERA.

By A. Earland.

The Foraminifera, in spite of their beauty, the important part which they have played in the building up of our earth, and the many interesting features of their life-history, have not met with so much favour among microscopists as many groups of far less importance. This comparative neglect is largely due to mistaken ideas as to the difficulty of obtaining and preparing suitable material, and it is proposed to show, so far as possible within the limits of a brief paper, that the collection of material is within the reach of every visitor to the seaside, and that the subsequent preparation presents no unusual difficulty to the microscopist.

The chief sources from which Foraminifera may be obtained are:—

1.—Dredged material, including anchor muds and sands.
2.—Shore gatherings made between tide marks.
3.—Sands, clays and limestones of various geological ages, especially from Cretaceous and Tertiary deposits.

Probably very few readers of Knowledge will have the opportunity of dredging for material, and anchor muds, which often contain an abundance of shallow water forms, are rarely obtainable, owing to the strange reluctance of seamen to lend themselves to the collection of scientific material, but the method of preparation for materials of this class is essentially the same as that for shore gatherings.

The apparatus required by the shore collector is of the simplest character, and consists of a scraper for removing the surface film of sand, which alone contains Foraminifera, a spoon for scraping material from ripple marks and depressions, and a metal box or canvas bag to contain the gathering. The best scraper is a thin plate of celloidin, such as a "Frena" film, as the thinness and flexibility of this material enable the collector to make his scraping with less admixture of sand than is possible with the glass or metal slip usually recommended for use.

Thus equipped, the collector sallies forth between the tides. Probably everyone has noticed when at the seaside the white lines which run along the sands, parallel with the retreating tide. A pocket lens shows that the white material consists of the minute shells of Foraminifera, of which some are of a lustrous white colour, due to the comparative abundance of the *Miliolidæ*—a family of common occurrence in shore gatherings, characterised by opaque shells of a milky white or "*Porcellanous*" texture, while others are more or less glassy and transparent. These "*Hyaline*" forms are much less noticeable to the naked eye. They are mixed in varying proportions with fragments of shell substance, *Ostracode* shells, cinders and the lighter *débris* of the shore, and their presence in these lines is due to the separating action of the water, which on a smaller scale we shall later on employ in the cleaning of our collected material. The rocking action of the wave on the extreme edge of the ebbing tide keeps these shells and fragments of light specific gravity in suspension until after the heavier sand grains have subsided, and so they are left behind in the ripple marks and depressions of the sand. Sometimes a local eddy of the tide, produced by the neighbourhood of a projecting rock, or of groynes and piers, causes the material to be gathered together in large quantities, which show as extensive white patches on the sand, and prove a real gold mine to the collector, who will then obtain more material in half an hour than he could gather in several days from the ripple marks.

The collector must not conclude that there are no Foraminifera present because there are no white patches to be seen, but remembering the way in which these patches are formed of the lighter *débris* of the shore, must look for Foraminifera wherever he observes that such *débris* has been deposited.

On every coast, at intervals of varying distance, there are spots which appear to be the foci of the local tides and currents, and here the material will be found in the greatest abundance. These points will soon be discovered and may be worked at every tide; but they vary continually with the set of the tide and wind, so that a spot which has proved rich may be quite bare the next year. Thus in October, 1896, I found Bognor—always a rich collecting ground—had its richest point to the west of the pier; while in September, 1901, there was very little material obtainable except at Felpham, two miles to the east, where the beach was thick with *débris*.

Having found the material the collection is quite an easy matter. With the celluloid scraper at an angle of about 60° the thin surface film of Foraminifera and *débris* is easily scraped into a heap and transferred to the box or bag. Great care must be exercised not to dig down into the sand, for nothing but a heavy bag will result from this, the Foraminifera being confined to the surface layer. The material thus collected may be either cleaned at once, or after being slowly dried—avoiding great heat—may be packed away in bottles for a more convenient period.

The apparatus required for the cleaning and preparation of the dried material is simple and inexpensive, and, if desired, much of it may be easily improvised. The most necessary articles are a photographic developing dish of china, quarter or half plate size, according to fancy, sieves of different sizes and materials according to the collector's pocket, a cylindrical glass jar with a lip and without any neck or constriction at the top, and a retort stand or tripod made of an iron ring rivetted on three legs.

The sieves can be made by any copper-smith, and it is very convenient to have a series of varying degrees of coarseness; but for the beginner two sieves of 40 and 120 meshes to the inch respectively will be sufficient. My own sieves are of copper, 4 inches high, 4 inches diameter at top, sloping to 3 inches diameter at the bottom. A smaller size made of telescope tubing $1\frac{1}{2}$ inches in diameter and 1 inch deep is very useful for washing small gatherings. Zinc, which is cheaper than copper, can be used for the sieves.

The wire gauze, which can be obtained from any large ironmonger, varies in price according to the number of meshes to the inch, ranging from a few pence per square foot to four shillings for the finest obtainable, which has 120 meshes to the inch, the diameter of each aperture being about $\frac{1}{200}$ inch. If a finer sieve than this is required, as it sometimes may be, the size of the aperture may be reduced by silver-plating the gauze, or preferably by the use of silk bolting cloth, which may be obtained up to 200 meshes to the inch. The wire gauze must be strained tightly over the sieve and soldered neatly to the edge, so that there is no ledge of solder inside to retain unwashed material. If silk is used, a sieve must be made without a bottom and having a turned-back edge at the lower end, so that the silk may be strained across and secured with string or a rubber band. The most useful sizes for a series of sieves are, in my opinion, 12, 20, 40, 80, 120 and 150 (silk) meshes to the inch.

Before cleaning the material it must be slowly and thoroughly dried. It should then be passed through the 12-mesh sieve to remove all the coarse *débris*, stones, shells, cinders, etc. None of the British shore species except parasitic forms will be found in this coarse residuum, but it should be looked over with a pocket lens for these or for abnormally large specimens. In some dredged materials and in tropical gatherings, however, this coarse residuum will be found to be full of Foraminifera.

The material which has passed through the 12-mesh sieve consists of Foraminifera mixed with other light *débris* and a considerable quantity of sand, and the collector must now proceed to eliminate the whole, or nearly the whole, of the sand and as much as possible of the other *débris* by means of two operations, "floating" and "rocking." If the quantity of material to be operated upon is small, it may be treated off-hand, but if there is much, it is well to sift it out into varying degrees of fineness, by passing it through a series of sieves. This will simplify the floating operations by ensuring that the particles are approximately of similar weight.

The floating operations must be performed at a sink, and, if possible, in daylight, the process being more uncertain by artificial light. The finest sieve (120 wire or 150 silk) is thoroughly wetted and rested on the tripod. The glass jar is then filled with water nearly to the brim, and a few spoonfuls of sand slowly poured into it. If the material is coarse the sand sinks instantly, and in the course of a few seconds most of the Foraminifera follow suit. By holding the jar to the light the course of the falling particles can be followed, and at the proper moment a sudden tilt empties the whole of the water and most of the Foraminifera into the sieve, the sand and a few of the heaviest "Forams" being left in the jar. The purity of the material in the sieve, which is usually called "floatings," will depend upon the skill and judgment of the operator, and is largely a matter of practice. The residuum in the jar must be washed out into a basin for further treatment, and the operation repeated with more sand and water until the whole of the gathering has been treated. The time allowed for subsidence will vary with the fineness of the sand, so that in the case of the finest siftings, nearly a minute may be required. The actual time can only be determined by watching the falling material in a strong light.

In the case of very fine sand the tension of the surface film of water is so great that the sand grains float almost as readily as the Foraminifera. This difficulty may be overcome by shaking up the contents of the jar, covering up the top with one's hand while so doing.

(*To be continued.*)

(*See Note headed "Practical" below.*)

Conducted by M. I. Cross.

RETROSPECTIVE.—The year 1901 did not witness any startling development in connection with the microscope, but it was one in which a steady progress was shown in nearly every department.

It witnessed the introduction of several new stands principally for students' use, two-speed fine adjustment devices, the increase in number and variety, and, above all, in the aplanatism of substage condensers and the substitution of actual working data for approximation in the case of tube lengths and cones of illumination.

In processes there were many new formulæ recorded, and judging from the number of articles which appeared on the subject, the science of micro-metallurgy is rapidly advancing. In the domain of preventive medicine, the best points of the microscope are becoming more fully appreciated and worked to greater advantage, and results are becoming increasingly reliable.

In literature the fresh edition of Carpenter on the Microscope was a feature of importance, and the paper read by Mr. J. W. Gordon before the Royal Microscopical Society in controversion of the Abbe theory of microscopic vision is still fresh in the memory.

On the whole, microscopists can congratulate themselves on the work done in the past year.

CO-OPERATION.—So much of the progress in microscopy in recent years has been attributable to the work of a few individuals that it has almost been lost sight of that the rank and file can and should do their share.

It is eminently desirable that a column of this kind should be made the medium for conveying the thought, research and observation of microscopists generally. The subject is so many-sided that it is impossible for any one individual to present it in its various aspects, and it is for those who catch glimpses and side lights that others do not notice, to add interest and increase knowledge by communicating their observations. There is scarcely a microscopist possessing enthusiasm, or who works thoughtfully, who has not found some little device of his own designing useful to him, or some process which has enabled him to produce more satisfactory results than by stereotyped means. Readers of these notes would always appreciate a short description of such methods, and by the communication of such ideas increased perfection would be attained.

PRACTICAL.—If microscopists generally can but be induced to become practical workers, that is, to prepare and mount their own slides, an increased interest and wider knowledge would be the result. The difficulty invariably is that suitable material cannot be procured: as an instance of this, I may mention that in the April number I offered to send a correspondent a small supply of Polcystina, and later mentioned that a supply was at the disposal of others. The applications that I received for samples indicated that there are numerous readers willing and anxious to mount their own specimens. Yet another instance; I have a letter from a correspondent, from which the following is an extract:—

"I hoped during the past summer to have been able to collect some specimens of Mycetozoa, but have not found one. What I want to suggest is that those collectors of such fungi who live in districts where they are found abundantly, should distribute their findings to those who are not so fortunate, by way of exchange, or for my own part I would willingly reimburse any expense in sending, as I should much value even a small collection. There must be many who have neither time nor opportunity of collecting who would gladly avail themselves of such an arrangement."

With these facts in view, it is proposed during the next few months, as far as possible, to offer material for readers to mount themselves and to give lucid instructions for doing the work.

In this number Mr. A. Earland contributes the first portion of an article on "Collecting and Preparing Foraminifera," and with the February number we shall hope to offer gratis to readers a supply of different kinds of material so that each may for himself practise the methods set forth.

I shall be very glad to hear from readers who are willing to help in this scheme, and who may be able to contribute notes from their own store of experience, or material for distribution.

I am glad also to be able to say that the experimental offer made in the last number to send a substage condenser for examination has received appreciation, and that manufacturers have arranged to co-operate so that the offer may be renewed on future occasions when other apparatus is reviewed.

NOTES AND QUERIES.

Rev. A. H. M.—It is certainly advisable to use colour sensitive plates for photo-micrography. I cannot recommend any special brand, but you would find Cadet Spectrum, Ilford Chromatic or Edward's Isochromatic quite satisfactory. Colour filters are also of very great importance, but you could readily learn their value from any work on photo-micrography. The photograph you send is a very good one of starch granules, especially considering it is the first attempt. You will find it necessary with a view to getting true images to use a larger aperture than you have in this instance, your condenser was evidently very much stopped down.

E. A.—No ordinary gas lamp is really satisfactory for critical micro work; still a very useful and simple pattern is employed in laboratories, and can be obtained for a nominal sum. It consists essentially of an upright rod attached to a round base, upon this rod a horizontal supporting bracket slides vertically and is fixed by a clamp screw. The horizontal arm carries an Argand burner and a chimney. I believe this can be obtained from Mr. A. H. Beard, of Lothian Street, Edinburgh, with a blue chimney. I know of no suitable acetylene lamp. Alternatively, the Welsbach mantle and burner can be used, of which you will obtain particulars from the Microscopical Notes in the May, 1901, number of KNOWLEDGE.

H. J. H.—The only maker I can trace who supplies an objective adjustable from 2″—4″ is W. Wray, of Laurel House, Highgate. I think you would get what you required from him.

G. W. B.—From the description you give you could not do better than have one of the Cathcart's pattern Microtomes; the difficulty you experience with the small hand section cutter would be satisfactorily overcome with this.

Reader of "Knowledge."—I am sorry to say I cannot identify the specimen you send, nor can I trace in any book the name of "Paludicella." I am not aware of any book being published dealing with Growths in Water-pipes.

Acarina.—The state of things that you describe in connection with your furniture is very disagreeable, but no serious consequence is to be apprehended so far as the wood work is concerned, from the acarus you have sent. This is the Book or Museum Mite—*Cheyletus eruditus.* I should be disposed to think that these live and multiply in the upholstering of the furniture. Shreds of sea-weed have been known to be substituted for hair in the stuffing of chairs, etc., and such material would form a good breeding ground for creatures of this description. They require a certain amount of dampness to propagate.

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.

PERIODICAL COMETS DUE IN 1902.—The returns of two comets of short period may be expected during the year. Swift's comet of 1895 which was computed to have a period of 7¼ years is due in the autumn, but the conditions will be less favourable than in 1895, and it is probable that this object will escape redetection. Tempel-Swift's comet will return to perihelion in November, and is likely to be successfully observed as in 1869, 1880, and 1891. Its period is as nearly as possible 5½ years, and the circumstances favour its visibility at every alternate return occurring at intervals of 11 years. In 1869 perihelion occurred on November 18, in 1880 on November 8, and in 1891 on November 14. On these occasions its apparent path in the heavens was nearly the same, and the comet will run a nearly similar course during the autumn and winter of 1902.

SWIFT'S COMET, 1899, I.—Definite orbit-elements have been computed by Mr. C. J. Merfield, of Sydney (*Ast. Nach.* 3747-8). The comet was first seen on March 3, 1899, and 605 observations for position were obtained between March 4 and August 10. The following are the elements deduced:—

$$T = 1899, \text{ April } 12, \cdot 978010 \text{ G. M. T.}$$

$$\left.\begin{aligned} \omega &= 8^\circ\ 41'\ 46{\cdot}48'' \\ \Omega &= 24^\circ\ 59'\ 59{\cdot}93'' \\ i &= 146^\circ\ 15'\ 30{\cdot}29'' \end{aligned}\right\} 1900.$$

$$\log. q = 9{\cdot}5139795.$$
$$\log. e = 0{\cdot}0001521.$$
$$e = 1{\cdot}0003503.$$

PERRINE'S COMET, 1897, I.—The orbit of this object has been investigated by Dr. J. Möller, who finds from observations between November 2, 1896, and April 29, 1897, that its path was decidedly hyperbolic. There appears, indeed, to have been only one other comet, observed in 1889, which exhibits this exceptional form of orbit in a more striking manner.

THE LEONID SHOWER OF 1901.—The nights of November 14 and 15 were generally clear in this country, though fog prevailed in some places. The meteors were attentively watched for, but only a moderate number seen. At short intervals a Leonid would shoot swiftly from the direction of "the Sickle," but nothing in the form of a brilliant shower was witnessed. At certain distant places observers appear to have been more successful according to some telegraphic reports published in the newspapers. Quite an active exhibition of Leonids was in fact recorded at a number of stations. The information comes from New York that on the early morning of November 15 a great shower was witnessed on board a steamer from New Orleans. On the morning of November 15 at the Leander-McCormick observatory of the University of Virginia, Va., Mr. C. P. Oliver, watching the sky from 4h. 50m. a.m. to daylight, saw 84 Leonids, the average being one per minute in spite of adverse atmospheric conditions. On the morning of November 16 at Phœnix, Ariz., a meteoric shower of great brilliancy was noted. It continued for half an hour during which it supplied 200 meteors. Just before daylight on November 16, at Los Angelos, Cal., the fall of Leonids was quite marked. One observer counted 385 meteors between 4 and 5 a.m., but the total number seen was estimated at over a thousand. From these and other reports it appears certain that the recent display was much richer than in 1899 or 1901, and the inference is that the tail end of the stream has not been disturbed to the same extent as the denser region. This leads to the hope that many Leonids will be visible in November, 1902, but unfortunately there will be a full moon to mar the spectacle.

FIREBALL OF NOVEMBER 10, 6H. 45M.—Scottish observers have supplied descriptions of a very brilliant meteor. At Crieff it was seen in the south-east "descending rapidly, and bursting into a number of rocket-like stars." At Aberdeen one observer says it flashed across the S.W. sky and lit up the earth like a search-light. Another observer there says that it was half the apparent diameter of the moon, and so bright as to be quite dazzling, and almost like a new sun. It crossed the sky from the region of α Pegasi to Altair. At Newtonhill it is described as crossing the heavens from E. to W., at about 40 degrees above the horizon, and making an angle of 20 degrees with it. In colour it appeared like a quantity of burning magnesium, and for the space of three seconds the country seemed as though lit by numbers of arc lamps. At Blairgowrie it emitted an intensely bright white light, and at Ellon, N.B., it was seen to burst out in Pegasus, and to travel in a direction to the S.W. From these and other accounts it appears that the meteor was a fine Taurid falling from a height of 64 to 55 miles from over the North Sea to Dunning, Perth. Length of path 73 miles, and velocity about 24 miles per second.

FIREBALL OF NOVEMBER 13, 6H. 53M.—Another magnificent meteor was seen in Scotland at this time, but only three descriptions have come to hand. Mr. A. C. Allen, of Keswick, says it passed to the right of α Cephei and δ Cygni, and to the left of γ Lyrae, and continued its flight some distance further. The meteor left a nebulous cloud near γ Lyrae for about 1½ minute, moving slowly to S.W., and curving into a crescent shape. The nucleus was accompanied throughout its course by a halo of about 45 degrees diameter. At Stair the meteor was estimated to have a breadth half the diameter of the full moon, and it broke into two pieces. It fell at any angle of 45 degrees from S.E. to S.W., and lit up the sky like a flash of lightning. "It only lasted 4 or 5 seconds." At Fife the meteor was exceedingly bright, of a greenish white colour, and it left a luminous streak for 4 or 5 seconds. It passed from about the centre of the square of Pegasus to α and β Capricorni. The radiant point was in Auriga probably at $87^\circ + 34^\circ$, and the height of the meteor was from about 90 to 52 miles from over the Cheviot Hills 12 miles E. of Langholm to the Irish Sea in longitude 5° 47′ W., and latitude 53° 38′ N. Path about 165 miles and velocity about 33 miles per second.

THE FACE OF THE SKY FOR JANUARY.

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

THE SUN.—On the 1st the sun rises at 8.8 A.M., and sets 3.59 P.M.; on the 31st he rises at 7.43 A.M., and sets at 4.44 P.M. The earth is at its least distance from the sun at 7 A.M. on the 1st; the apparent diameter of the sun then being at its maximum, 32′ 35″·16; the horizontal parallax is then 8″·95, also a maximum.

Few sunspots are to be expected.

THE MOON:—

	Phases.	h. m.
Jan. 1	☾ Last quarter	4 8 P.M.
,, 9	● New Moon	9 15 P.M.
,, 16	☽ First quarter	6 38 A.M.
,, 23	○ Full Moon	0 6 A.M.
,, 31	☾ Last quarter	1 9 P.M.

The more interesting occultations visible at Greenwich are as indicated in the following table:—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Jan. 12	c^1 Capricorni	5·2	4 17 P.M.	73	53	5 27 P.M.	238	209	2 19
,, 13	κ Aquarii	5·5	6 23 P.M.	10	340	7 1 P.M.	301	267	3 21
,, 21	71 Orionis	5·1	8 15 P.M	22	50	8 39 P.M.	343	6	11 23
,, 24	κ Cancri	5·0	6 7 P.M.	110	147	7 1 P.M.	276	315	14 21

THE PLANETS.—Mercury is not well situated for observation, being in superior conjunction with the sun on the 1st; towards the end of the month it will be an evening star setting a little more than an hour after the sun, but even then it is too far south for easy observation.

Venus remains an evening star and attains her *greatest brilliancy* on the 9th, the apparent diameter then being 40″. Throughout the month she will form a conspicuous object in the south-west shortly after sunset, and with the exception of the last few days the planet sets three hours in the rear of the sun, but has a more northerly declination of about 10°. The planet is at the stationary point on the 22nd, after which date her motion will be retrograde or westerly.

Mars is not well placed for observation, setting a little more than an hour after the sun. Towards the end of the month the planet will appear in proximity to Mercury, the two planets being in conjunction with each other on the 23rd; Mercury being 25′ to the south.

Jupiter and Saturn are invisible, both being in conjunction with the sun during the month, the latter on the 9th, the former on the 15th.

Uranus is only visible shortly before sunrise, and being very low is not suitable for observation.

Neptune continues to be favourably situated during this month. He crosses the meridian at 11.13 p.m. on the 1st, and at 9.2 p.m. on the 31st. The planet is in the most westerly part of Gemini, but its retrograde motion brings it into Taurus at the close of the month. The nearest bright stars are still η and 1 Geminorum, a continuation of the table given last month will enable it to be picked up readily when the telescope has been pointed to the two stars named above.

Date.	Neptune.		η Geminorum. Mag. 3·2–4·2.		1 Geminorum. Mag. 4·3.	
	R.A. h. m. s.	Dec. ° ′	R.A. h. m. s.	Dec. ° ′	R.A. h. m. s.	Dec. ° ′
Jan. 9	5 58 10	N.22 15				
„ 18	5 57 11	22 16	6 9 0	N.22 32	5 58 12	N.23 16
„ 27	5 56 18	22 16				

On the night of the 9th the planet has the same right ascension as 1 Geminorum, the telescope will therefore only need depressing 1° to bring the planet into the field of view.

The Stars.—The positions of the principal constellations and stars about 9 p.m. at the middle of the month are as follows:—

Zenith . Perseus, Auriga (*Capella*).

South . Orion, Taurus, Pleiades, with Aries and Cetus towards the south-west, and *Procyon* and *Sirius* towards the south-east.

East . . Leo (*Regulus*) and Cancer low down, whilst Gemini (*Castor* and *Pollux*) is high up.

West . . Pegasus, Andromeda, Pisces, with Cygnus in north-west.

North . Ursa Minor and Draco below *Polaris*, with Cassiopeia to the left, and Ursa Major to the right.

Minima of Algol occur at convenient times on the 5th at 11.29 p.m., on the 8th at 8.18 p.m., on the 28th at 10.1 p.m. and on the 31st at 6.49 p.m.

Chess Column.

By C. D. Locock, b.a.

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

Solutions of December Problems.

(C. D. Locock.)

No. 1.

Key-move.—1. B to B2.

If 1. . . . K to Q4, 2. R to B5ch, etc.
1. . . . Kt to B2, 2. B to K4, etc.
1. . . . Kt to Kt3ch, 2. Kt × Kt, etc.

No. 2.

Key-move.—1. Kt to B2.

If 1. . . . P to R7, 2. R to R4ch, etc.
1. . . . P to Kt5, 2. Kt × RP, etc.
[Not 2. R × QKtP as given by two or three solvers.]
1. . . . K to R3, 2. R to R4ch, etc.

[A second solution by Kt to R6 was intentionally left, in the hope that it would limit the number of "ties" in the solution tourney. The expectation has been realised, the play in the second solution having sufficient merit to cause it to be mistaken for the author's intention. As a matter of fact, considerably more solvers have sent Kt to R6 than Kt to B2. The "cook" could presumably have been stopped by the addition of a White Pawn at QR6 and a Black Pawn at QR2.]

Correct Solutions of both problems received from J. Baddeley (6), H. Le Jeune (6), G. Groom (5), F. J. Lea (5), S. G. Luckock (6), W. de P. Crousaz (6), C. C. Massey (5), G. W. (6), Alpha (6), G. W. Middleton (7), W. Nash (6), W. H. Boyes (6), C. Johnston (7), A. C. Challenger (6), W. Jay (7), Major Nangle (6), Vivien H. Macmeikan (6), F. Dennis (6), J. E. Broadbent (7).

Of No. 2 only, from G. A. Forde, Capt. (3), W. H. S. M. (3), A. E. Whitehouse (3), W. V. M. Popham (3).

G. Groom.—Kt to R2 will not solve No. 2.

W. V. M. Popham.—Your solution to No. 1 (November) was received too late to acknowledge. In No. 1 (December), 1. B to Kt3 is met only by 1. . . . K to Q4, and if then 2. Kt to Q2ch, K × Kt.

W. H. S. M.—K to Q8 would be all right but for 1. . . . K to Q4.

W. de P. Crousaz.—I regret to find that you were previously credited with one point too much.

J. Baddeley.—Knowledge appears to have reached you two or three days late.

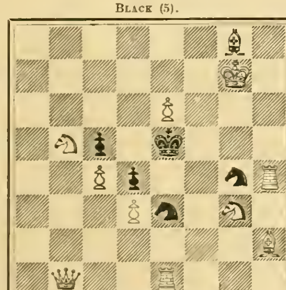
A. E. Whitehouse.—Please see answer to *W. V. M. P.* Very glad that you and others have continued to the end in spite of adversity.

PROBLEMS.

No. 1

By S. G. Luckock.

Black (5).



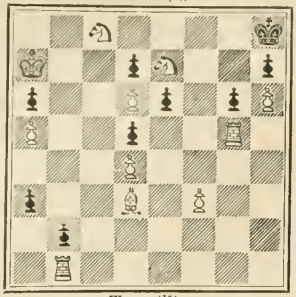
White (11).

White mates in two moves.

No. 2.

By C. D. Locock and J. K. Macmeikan.

BLACK (9).



WHITE (11).

White mates in four moves.

After a close and exciting contest, the Solution Tournament, which has been in progress since last January, has come to an end. Last month's problems had the effect of reducing the number of ties to a minimum, the result being that Messrs. W. Jay and C. Johnston tie for the first and second prizes, while Messrs. A. C. Challenger and G. W. Middleton obtain the equal third and fourth prizes. While congratulating these expert solvers on their well-deserved success, we must also condole with Mr. Challenger on losing his chance of the first prize at the last moment, the same applying to Messrs Dennis, Groom, Luckock, and W. H. S. M., in regard to the other prizes. We have also to thank the many solvers who, after losing points at an early stage, continued to do their best, and have in many cases achieved prominent places.

The following is the order of the first sixteen :—

1. W. Jay, 68; C. Johnston, 68 } tie for first and second prizes.
3. A. C. Challenger, 67; G. W. Middleton, 67 } equal third and fourth prizes.
5. F. Dennis, 66; S. G. Luckock, 66.
7. J. Baddeley, 65; G. Groom, 65.
9. J. E. Broadbent, 64; G. W., 64.
11. H. Le Jeune, 63; W. H. S. M., 63; W. Nash, 63.
14. Vivien H. Macmeikan, 62.
15. W. de P. Crousaz, 61.
16. C. C. Massey, 59.

We hope that all the above, and many others, will compete in the Solution Tourney which commences in the May number, and will continue to the end of the year.

An attempt will be made to decide the tie for first and second places by means of the four-move problem printed above, and the three-move problem sent by post to Messrs. Jay and Johnston. The conditions for both problems will be the same, viz.:—*Every correct key*, 3 points, 2 points being deducted for every incorrect claim. In the event of further equality, it is suggested that the prizes should be divided. The award will remain open for one month. Meanwhile, perhaps Messrs. Challenger and Middleton will let us know at what date they would prefer their six numbers of KNOWLEDGE to commence.

THREE-MOVE PROBLEM TOURNEY.

1st Prize, One-and-a-Half Guineas; 2nd Prize, Fifteen Shillings; 3rd Prize, "Knowledge," free for 12 months.

The Conditions are as follows :—

1. Each competitor may send not more than one three-move unconditional direct-mate problem (diagrammed).
2. Competing positions must be original and unpublished.
3. Each problem must be accompanied by a motto and full solution with a sealed envelope containing the composer's name and address.
4. Competing positions must reach Mr. C. D. Locock, Netherfield, Camberley, England, on or before April 10th, 1902.
5. The Chess Editor reserves the right of excluding manifestly impossible, unsound, or inferior positions.
6. The adjudication will be partly by solvers and partly by the Chess Editor.

All solvers who solve correctly every problem will be entitled to vote on their merits. The six or eight problems thus selected will then be adjudicated on by the Chess Editor, whose decision will be final.

A SOLUTION TOURNEY will commence at the same time. Full particulars will be given next month; in the meantime it may be stated that the winner will hold for 12 months a Silver Challenge Trophy, which will become his property should he win it three years in succession, or four years altogether. Second and Third Prizes will also be given.

CHESS INTELLIGENCE.

A Devon and Cornwall Chess Tournament is announced to take place at Plymouth during the second week in January. Entries, with entrance fee, 10s. 6d., should be sent to the Chess-Editor, *Western Morning News*, on or before December 28.

It is with the greatest regret that we have to announce the death of the Rev. John Owen, for forty years Vicar of Hooton, Cheshire. Mr. Owen was a member of the St. George's and Liverpool Chess Clubs, and, more recently, of the British Chess Club. For something like half-a-century he was one of the very strongest players in England, and to the end he never lost his skill. Mr. Owen was a frequent competitor in the meetings of the Counties' Chess Association, and took part in the International Tournaments held at Bradford in 1888, and Manchester in 1890. But in spite of his numerous successes Mr. Owen will perhaps chiefly be remembered for the match which, playing under the name of "Alter," he lost, receiving the odds of Pawn and move, to Paul Morphy in 1858. Mr. Owen invariably played the "close game," both as first and second player, his speciality being the Queen's Fianchetto defence. He delighted in crowded positions, and yet his games were seldom dull, few players being more brilliant when the opportunity arose.

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CONTENTS.

ACROSS RUSSIAN LAPLAND IN SEARCH OF BIRDS.

By Harry F. Witherby, F.Z.S., M.B.O.U.

I.—VARDOE AND THE WHITE SEA.

There are some people, one might almost term them a fraternity, for whom a wild and desolate land has a strange fascination. A barren and forsaken spot, the very aspect of which casts a gloom over the ordinary mortal, is for them a paradise. There they are thrilled with joy, an overwhelming feeling of freedom takes possession of them, and a desire to race over the country and explore it to the horizon seizes upon them like a mania. For such the regions to the north of the arctic circle have many attractions, and when once the wealth of wildness and solitude to be found there have been tasted by one infected with this craze then ever afterwards the North Pole will draw him as surely as it attracts the needle of a compass.

Ornithologists, and English ornithologists especially, whether worshippers of solitude or not, seem to be particularly devoted to those northern regions where in summer the sun reigns supreme. The northern parts of Norway, Lapland, and Siberia have been so thoroughly explored by them that it was only after a long search that my friend Mr. A. E. Hamerton and myself could fix on a route in those regions which had not been visited by some brother craftsman. We agreed at length to journey to Archangel by sea, and then proceeding to the southern end of the Kola peninsula or Russian Lapland to walk across to the Arctic Ocean along the route taken by Messrs. Edward Rae and H. P. Brandreth.* As far as we could discover this country had not been traversed by any other Englishmen, and although Russian ornithologists had worked there in the winter when the snow makes travelling easy, very little was known of the birds inhabiting the interior of the peninsula in summer.

Starting from home early in June, 1899, and crossing the North Sea, whose unkindly nature is well known to all who visit Norway, we soon arrived at Christiania. An eighteen hours' railway journey thence brought us to Trondhjem where we embarked on the good ship "Sigurd Jarl" bound for Vardoe. It was a pleasant voyage in and out amongst the islands, and through rocky channels where the snow-capped hills rise sheer out of the sea. We passed the Lofoden Islands, devoted to fisheries, and Tromsoe, and arrived at Hammerfest, where the streets were still coated with ice and bordered with heaps of dirty snow.

From Hammerfest a few hours of rough water round the North Cape brought us to Vardoe. Here we learnt that the "oldest inhabitant" could not remember so late a season, and that the Russian boat that was to take us to Archangel had not yet broken through the ice in the White Sea.

However, a few days in Vardoe were well spent. The town and the small island upon which it stands are entirely given up to cod fish. Vardoe is built along the edge of its harbour, and the harbour is fringed with small quays, which are at all times scenes of the greatest activity, day and night in this latitude being scarcely distinguishable. Open boats, shaped exactly like the old viking ships, rowed or sailed by hardy Norsemen, are continually coming into the harbour laden with cod and red mullet, while others are going out to the fishing grounds away in the Arctic Ocean, often

A Boat-load of Cod on the Quay at Vardoe.

10 or 15 miles from land. The quays are always full of fish, which are hauled up from the boats in baskets

* See "The White Sea Peninsula," by Edward Rae, F.R.G.S. (Murray), 1881.

by means of ropes coiled round large wheels. On the quays men, women, and children are hard at work sorting, gutting, and salting fish, extracting the liver oil, tying the fish in pairs tail to tail, threading the cods' heads on lines, baiting the hooks and coiling the lines into baskets ready for the fishermen. The fish and the heads are hung up to dry on laths fixed to poles all over the island, whilst discarded fish and those dropped accidentally lie about everywhere on the quays and in the streets and are eaten with avidity by cats, goats, and cows. Yet for all this wealth of fish you cannot get a fresh cod to eat, as they are all salted and dried and sent to Russia and Spain, while the heads are dried and used for manure. But so pure and fresh is the air that, notwithstanding all the mass of corruption on the island, there is very little smell, and even the decomposing cods' heads scarcely taint the fresh northern breezes.

The drying grounds proved most interesting to us, especially where there hung rows and rows of heads, as the maggots in these attracted numbers of birds. Snow buntings† in their beautiful velvety black and snow white summer plumage were numerous, while elegant shore larks,‡ with their handsome black ear tufts, evidently found the cods' heads good hunting

A Quay at Vardoe with Cods' Heads in Strings.

grounds, and their pretty little songs testified to their contentedness. Then in the marshy ground under the drying fish we found Temminck stints,§ which rose fluttering into the air calling rapidly tzi-tzi-tzi. Round the coast on the sea-washed rocks were purple sandpipers|| in all the glory of their summer sheen. In the sea were numerous eider ducks,¶ the drakes in black and white and sea-green, cooing like stock doves, and flirting with their sombre coloured mates. Black guillemots** were in swarms, and their soft mellow whistles floated peacefully over the cold water, while gulls of many sorts flew backwards and forwards overhead. On the mainland, which we visited one day, or was it night, we found still more birds. The country was white with snow, but here and there on patches of green where the snow had melted, and on the shore we found the birds. Dotterels,†† with all their well-known silliness, allowed us to approach within a few yards, but sanderlings‡‡ and little stints,§§ in their rich brown breeding plumage, were more wary. Lapland buntings|||| were building their nests on the dryest parts available of the wet ground uncovered by snow, and the male birds often rose into the air singing, like pipits, on the wing, soft little piping songs. Then we saw three Arctic skuas,¶¶ those robber gulls which chase their hard-working cousins, and, making them disgorge their honestly earned prey, swoop down and catch it ere it reaches the surface of the water. As is well known these birds vary greatly in colouring from sooty black all over to greyish white on the under parts. Of the three we saw two were dark and one light. We approached them, and while one bird flew away the other two swooped down near to us several times, and then settled on the ground at some distance, and spreading out their wings, quivered them and uttered a plaintive meauw. Knowing by this that they must have eggs, we searched about, and on a strip of ground from which the wind had swept the snow, we found a small hollow lined with moss and lichen, and containing two dark brown eggs. The third bird, which had flown away, we noticed was being chased and buffeted continually by the other two, and we could not understand what was his share in this domestic scene. Some weeks afterwards in Lapland I found a similar trio, and managed to shoot the third bird, which in this case also appeared to be "one too many," and was continually chased and ill used by the other two. My shot only winged it, and the bird was floating down to the ground when the other two meanly attacked it and knocked it over, so that it fell in the middle of a very soft bog. The bog appeared to be of an unfathomable depth, but I was determined to get the bird and clear up the mystery, so I took off my coat and in a couple of hours managed by great exertions to pull up by the roots eight fair sized birch trees and build a bridge over the bog to the bird. It was a dark coloured specimen, but the rufous edgings to many of the feathers on the back proved it to be an immature bird evidently hatched the year before. So that presumably in two cases a pair of adult birds was attended by a single youngster whose presence evidently interfered with domestic bliss.

From Vardoe we journeyed on by a small coasting steamer to a place called Petschenga, where we were to meet the Archangel boat. The Arctic Sea was wonderfully calm, and we were delighted to see some way from land a flock of those charming little birds the red-necked phalaropes,*** floating like corks upon the water. They were as tame as farmyard chickens, and were so buoyant that on alighting on the water they appeared scarcely to touch it, and the sea was so still and glassy that one might have thought they were resting upon ice rather than water. At Petschenga the snow was waist deep and very soft, so that we found we could not explore the country far. We got along well on the top of the snow for some distance, when suddenly the crust gave way and we were floundering about up to our armpits in wet and clinging snow. Near the water, however, there were places bare of snow, but very wet. These spots were full of birds, several of which were building nests, seeming determined to take full advantage of the

† *Plectrophenax nivalis.* ‡ *Otocorys alpestris.*
§ *Tringa temmincki.* || *Tringa striata.*
¶ *Somateria mollissima.* ** *Uria grylle.*
†† *Eudromias morinellus.*

‡‡ *Calidris arenaria.* §§ *Tringa minuta.*
|||| *Calcarius lapponicus.* ¶¶ *Stercorarius crepidatus.*
*** *Phalaropus hyperboreus.*

short northern summer. We watched a pair of little stints, those tiny snipe-like birds, love-making with twitterings, and fluttering of wings within a few yards of us, while the male red-throated pipits††† were singing encouragingly to their mates who were hard at work building nests on little mounds raised above the general slush.

When at length we boarded the Russian cargo boat which was to take us to Archangel we found our fellow passengers were mostly rough unkempt Russian peasants, with tawny beards and long hair. They were clothed in long sheepskin coats, high black boots, and round fur caps, and they appeared very hardy but very dirty. The steamer stopped every few hours at the small fishing stations along the Murman coast to land a few stores, and to take on board barrels of fish, bundles of porpoise skins, and other fishy cargo. The landing and shipping of this cargo, which was done by small boats, invariably caused an immense excitement. Each boat tried its best to get to the side of the steamer first, and the gesticulations, shouts, curses, and general hubbub raised by the process might well have been products of the fiery south or east rather than of the grave and solemn north. We were glad when all the villages were past, and we left the coast and entered the White Sea.

We went to sleep that night in high hopes that on waking we should be nearing Archangel. But when we awoke the steamer was laid to in a thick fog. In a few hours the fog lifted, and revealed a sea covered with ice—white and dazzling—as far as the eye could see. A man was sent aloft, but no channel could be found so we slowly skirted the sea of ice. But almost before we could take in the scene, the merciless fog dropped down again like a curtain and shut out everything from sight. For five days we lay surrounded by ice and fog, scarcely moving at all. At first the captain, hoping for the best, pushed his boat into the ice, and for hours we struggled with the floes. The steamer was sharp in the bows and had twin screws, both bad faults for an ice boat. The bows when driven into a floe got jambed, and the boat had to be backed out, while the screws, being quite unprotected, were in continual danger of being broken by a collision with the ice, which was very thick and often reached far below the keel of the ship. Consequently men had to be stationed fore and aft with long fir poles to push off the floes, while the captain ran from side to side of the bridge signalling every moment to the engineers to stop one screw or the other as it was in danger of fouling the ice. The crew worked like slaves for hours, but the only result of their labours was to fix the ship more firmly than ever in the ice. Then the fog lifted for a brief half-hour and showed us to be in an uncomfortable position which might result in the ship being nipped. By dint of hard work she was turned round, and a day of toil brought us once more out of the ice. The captain had been twenty-four hours on the bridge working hard in a freezing fog, and the crew were worn out, so for the next few days we hove to and waited. The monotony was broken only by the melancholy screech of syrens, for there were fourteen other boats round about us, all waiting for the fog to clear and the ice to shift. A little excitement was caused one day when, judging by the quality of the food, we appeared to be running short of provisions, and on another when we were told that our coal was giving out. However, a few broad hints to the steward brought forth better food, and a begging tour to the neighbouring ships resulted in one coming alongside and filling our bunkers with coal.

At last the fog lifted, and making a bold move our bright little captain turned his boat round and steamed right back to the coast. The set of the tide had made a broad lane of clear water between the land and the ice, and down this we steamed full speed ahead, slowing up now and then to thread our way through some detached floes or to force a passage through a narrow belt of ice. Before the tide changed and brought down the ice again to the shore we were through, and steaming gaily for Archangel. While we raced the tide with cheerful hearts our eyes were treated to the most glorious spectacle. The fog had completely cleared, and the sky was cloudless. For an hour—between eleven o'clock and midnight—the sun just skirted the horizon as though uncertain whether to go below or not. The heat went out of it, and its brilliancy faded, but the effect of its combined setting and rising was exquisite. The horizon shone like gold, and stretching from it lay the snow-covered ice, blushed with a delicate pink, and with here and there on its surface a pool shining like an emerald, while at our feet the dark, deep blue of the open water served as a strong and fitting contrast to the delicious delicacy of colouring beyond. As the sun rose higher the colours faded and we went below cold but happy. While we slept we crossed the arctic circle once more, and when we awoke some hours later the air was balmy, and the delicious scent of pines drifted through the cabin port hole. We were in the delta of the Dwina, and steering up one of its narrow channels we soon arrived at Solombala, the port of Archangel.

††† *Anthus cervinus.*

VEGETABLE MIMICRY AND HOMOMORPHISM.—I.

By Rev. Alex. S. Wilson, M.A., B.Sc.

Besides the family likeness and similarity of structure characteristic of closely allied organisms, other resemblances included under the terms Mimicry and Homomorphism, are observed among living things which cannot be referred to a common ancestry since they are presented by plants and animals whose affinities are more or less remote. If the resemblance confers any benefit on either species it is spoken of as a case of Mimicry, but if it results from the operation of general laws and is not directly advantageous, the likeness is described as Homomorphic. It is not always possible to draw a sharp line between the two, and homomorphism not improbably represents one stage in the development of mimetic species.

Both kinds of resemblance are common in the animal kingdom. The most perfect examples of mimicry occur among butterflies, particularly among the Pieridæ of South America, where it was first observed by Mr. Bates. Most members of this family resemble the ordinary cabbage-butterfly, but it includes species of *Leptalis*, which imitate the Heliconidæ in the shape and bright parti-coloured markings of their wings. The latter have a nauseous taste and are not molested by birds. So exact is the imitation that even experienced entomologists have been deceived. In the Malayan Archipelago Mr. A. R. Wallace found species of *Papilio* mimicking certain other families which have an offensive odour and are, like the Heliconidæ, distasteful to birds.

The curious walking-leaves and stick insects belong to the Phasmidæ, a family allied to the locusts and grasshoppers. To such a degree has the imitation been carried in Ceroxylus that the insect looks exactly like a twig overgrown with moss. By reason of its resemblance

Fig. 1.—Mimicry in Butterflies. 1. Leptalis Type. 2. Leptalis mimicking. 3. Ithomia, model.

to a bee the fly *Volucella* can enter the hive and leave its eggs without exciting the suspicions of the bees. Certain clear-winged moths are also liable to be mistaken for bees and hornets.

Protective colouring is very common in the plumage of birds, a green woodpecker, for instance, is not easily distinguished amid the surrounding moss and foliage. Cuckoos are often mistaken for hawks, which they much resemble both in appearance and flight. Dun-coloured, tawny, striped and spotted animals are difficult to detect amid their native haunts. The fur of a number like the arctic hare and fox becomes white in winter, harmonizing with the snow-covered ground. Most of the autumnal Lepidoptera are brown or golden, while the winter species usually assume a grey or silvery garb. Snails and caterpillars are familiar instances of protective colouring, but this mode of concealment is so general throughout the animal kingdom that it is unnecessary to multiply examples.

Animal Homomorphism is illustrated by the Polyzoa, which outwardly resemble the Hydroid Polypes and corals, though they belong to a different sub-kingdom. Amphibians like *Caecilia* assume a worm-like aspect, and armoured creatures such as the tortoise, armadillo, ganoid fishes and crustaceans present analogous forms. Many of the smaller crustaceans take on a resemblance to various families of insects; some butterflies and moths in general appearance come very near the humming birds. The porcupine is a rodent, the hedgehog one of the Insectivora, their relationship is not so close as one might imagine from their external appearance. Among the Marsupials of Australia forms occur closely corresponding to members of other orders inhabiting other regions. The resemblances of the shrew to the common mouse, of the bat to a bird, and of the whale and dolphin to a fish are examples of homomorphism which will occur to every reader.

Similar habits, if these may be included under homomorphism, are sometimes possessed by animals not closely related. The exceptional habit of the cuckoo is shared by several North American birds belonging to a widely different family. Mr. Darwin mentions species of *Molthrus* allied to the starlings which resemble the cuckoo in building no nest of their own and in laying their eggs in the nests of other birds. A similar habit appears in the cuckoo-bees. There is also the case of the cuckoo-flies, which live as inquilines in the galls of other insects. The ventriloquism or intentional imitation of the mocking bird also might almost be viewed as a case of homomorphism.

The vital phenomena of plants and animals are so near akin that it would be strange if we did not meet with corresponding facts in the vegetable kingdom. Mimicry is perhaps more frequent in the seed than in any other part of the vegetable organism; it occurs, however, in other organs, and even the entire plant body may assume a deceptive appearance. A well-known example is the white dead nettle, which so closely resembles the stinging nettle in size and in the shape and arrangement of its leaves. In systematic position the two plants are widely removed from each other, but they grow in similar situations and are easily mistaken; anyone who has occasion to collect quantities of *Lamium* is almost sure to get his hands stung by *Urtica*, an experience calculated to convince one of the efficacy of protective resemblance. Among animals it is species provided with formidable weapons of defence that are most frequently mimicked by weak defenceless creatures.

Fig. 2.—Urtica and Lamium.

The stinging nettle is therefore a very likely model for unprotected plants to copy.

A somewhat analogous case is the yellow bugle of the Riviera, which has its leaves crowded and divided into three linear lobes, some of which are again divided. In this the plant differs very greatly from its allies; it has, however, acquired a very striking resemblance to a species of *Euphorbia*, abundant on the Riviera. The acrid juice of the Euphorbias secures them immunity against a host of enemies. As the two plants grow together there is little room to doubt that, like the dead nettle, the bugle profits by its likeness to its well protected neighbour.

The rare heath *Menziesia caerulea*, thought to be protected by its marked resemblance to the Crowberry (*Empetrum nigrum*), has also been adduced as a probable case of mimicry.

Mr. A. R. Wallace in *Tropical Nature* refers to the stone *mesembryanthemum* at the Cape described by Dr. Burchell, which closely resembles in form and colour the stones among which it grows; on this account its discoverer believes the juicy little plant generally escapes the notice of cattle and wild herbivorous animals. Mr. J. P. Mansel Weale mentions that in Karoo many plants have tuberous roots above the soil resembling stones so perfectly that it is almost impossible to distinguish them. The tubers of the potato itself in its native home may perhaps be protected in this way.

The last-mentioned observer has also noted a labiate plant, *Ajuga ophrydis*, in South Africa which bears a strong resemblance to an orchid. As this is the only species of bugle in the district Mr. Wallace thinks the flower profits by the mimicry and succeeds in attracting the insects required for its fertilisation. A species of balsam at the Cape has also acquired an orchid-like aspect. At least one phanerogam bears a lichen-like aspect; *Tillandsia Usneoides*, one of the pine-apple family, grows on trees in tropical America and has a resemblance to a shaggy lichen so marked that it is generally mistaken for a plant of that order. The fly agaric, our most conspicuously coloured fungus, according to Dr. Plowright, is closely imitated by a parasitic flowering plant *Balanophora volucrata*, the scarlet cap, the dotted warts, the white stem and volva being all accurately represented.

THE HISTORY OF FAHRENHEIT'S THERMOMETER.

By Sir Samuel Wilks, M.D., LL.D., F.R.S.

The origin of Fahrenheit's thermometer and the meaning of the scale are not to be found in any work on natural philosophy or chemistry with which I am acquainted, and all the professors whom I have met have expressed like ignorance. Although the instrument appears inexplicable and unwieldy, there is great interest attached to its history, when we learn that it was really invented by Sir Isaac Newton, and that the starting point of his scale was the heat of the human body.

Newton's paper is to be found in the *Philosophical Transactions* for the year 1701. He describes his instrument as a glass tube filled with linseed oil, and to it he attached a scale to measure the degree of heat of the liquid into which he plunged it. His lowest point was that of freezing, as his highest was that of boiling water. He chose for the starting point on his scale the heat of the human body, and this he called by the round number 12, the duodecimal system being then in use; that is, he divided the space between the freezing point and the temperature of the body into twelve parts. He further stated that the boiling point would be about 30, as it was nearly three times that of the human body (*see* Fig. 1).

A few years afterwards, when Fahrenheit was working at the subject of heat, he took Newton's instruments for his experiments, but, finding the scale not minute enough, he divided each degree into two parts, and so made it measure 24 instead of 12. He also did more, for finding he could obtain lower temperatures than freezing, and notably that of ice and salt mixed together, he took this for his starting point. It was from this point he began to count 24 degrees up to body heat. This made, by his measurements, 8 the point for freezing. Boiling point he made 53. It then became zero, freezing 8, body heat 24, and boiling water 53. This was really the same as Newton's, only the scale started lower and the numbers were doubled (*see* Fig. 2).

Later on, finding that he could measure increments of heat more minutely, Fahrenheit divided each degree into four parts. It will now be seen that if the numbers just

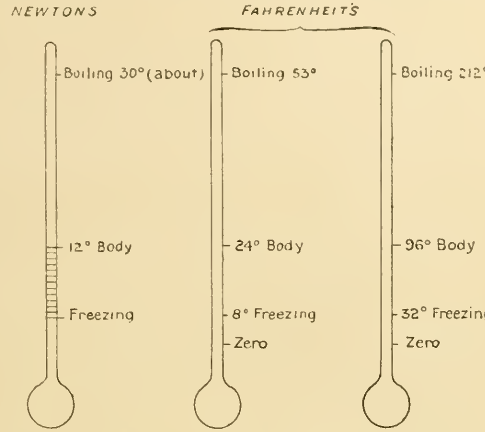


FIG 1 FIG 2 FIG.3

mentioned are multiplied by four we have the thermometer which is now in use. Beginning with zero, freezing becomes 32, the body heat 96, and boiling point 212. This is the scale which Fahrenheit made, and the reasons for his doing so. It is the one which has been in use ever since (*see* Fig 3).

Of late years, when more accurate readings were required, each degree was divided into ten. This brings the decimal system into a scale which was before wholly duodecimal. It may be stated that Newton was aware that blood heat was higher than that which he obtained by placing the thermometer under the arm to measure the body heat.

SILK AND ITS PRODUCERS.

By R. Lydekker.

Whereas wool, fur, and hair are exclusively the products of a single class of vertebrate animals, namely, the mammalia, silk is as exclusively a product of invertebrate creatures. In place, however, of being produced by one single class, it is yielded in a workable form by certain members of at least three distinct classes of the lower animals, namely, the lepidopterous insects, the spiders, and the bivalve molluscs. At present, however, it is only the product of the caterpillars of a comparatively few species of moths that is of any real commercial importance.

Unfortunately the manufacture of raw silk into the finished article is one of those industries which have to a great extent passed out of the hands of the British workman into those of his foreign rivals; and the Spitalfields hand-loom weaver is almost as extinct as the dodo, while the riband-mills of Coventry have largely been superseded by cycle-manufactories.

According to an article which appeared a few years ago in *Commercial Intelligence*, it seems that during 1898 the imports into Great Britain of manufactured silken goods amounted to over twenty millions in value, while the imports of raw silk were only about one million. Inclusive of the necessary labour, the value of this imported raw material when worked up into silk goods would probably not be more than between two and three millions; and it would thus appear that out of a total consumption of some twenty-two or twenty-three millions sterling worth of manufactured silk only a very small fraction is made at home.

The British silk industry has, indeed, been gradually languishing and diminishing for a period of something over sixty years—practically during the whole of the Victorian era. In 1838, according to the same source of information, when the population of the British Isles was only twenty-five millions, the annual consumption of home-made hand-loom woven silken goods was equivalent to eight shillings and sixpence per head. In 1898, on the other hand, when the population was reckoned at about thirty-eight millions, the consumption of silk goods manufactured abroad was equivalent to ten shillings and sixpence per head, while that of British-made silk reached only a miserable eighteenpence per head.

It is not that hand-woven British goods are inferior in quality and wearing power to the foreign articles by which they have been so largely supplanted. Quite the contrary. And now that raw silk is exported from India, China, and Japan in much better condition for manufacture and at a lower price than in 1838, there seems no reason why it should not pay to work it up in this country.

Although the caterpillars of many species of moths make silken cocoons for the protection of their chrysalids, and the cocoons of several of these are used to supply commercial silk, the great bulk of the supply is afforded by the caterpillar of the silk-moth, the so-called "silk-worm." Curiously enough, the silk-moth is a purely domesticated animal, whose wild ancestor is now unknown. Even the real home of this insect is not definitely ascertained, some authorities believing northern China to be the original habitat of *Bombyx mori*, as the species is technically called, while others think that Bengal has a stronger claim to the honour. Be this as it may, the species has been domesticated for an immense period in China, some say since about 1640 B.C.; it was introduced into Constantinople in the sixth century of our era, whence it was carried into France in the year 1494. It is now distributed over a large portion of the globe; and as a consequence of such a wide range and such a long period of domestication it has altered considerably from the parent form, and has likewise developed several local modifications. Evidence of its alteration from the parent form (whatever that may be) is afforded by the aborted condition of the wings of the adult moth, which are so weak as to render the insect incapable of flight. By some it has been said that if the moths be reared in the open air in perfect freedom they will recover the power of flight in the course of a few generations, but since it is also stated that the caterpillars when turned out on trees are helpless, this requires confirmation. Variation is shown by the fact that in one breed the cocoon is yellow while in another it is white; and this, coupled with other variations, has led some authorities to believe that the domesticated form is derived from more than one wild species. This view has, however, not met with general acceptation.

The silk is found within the body of the caterpillar in a pair of glands of somewhat complex structure, and is there in a viscid condition. The ducts of the two glands unite into one common channel, so that their products are united before emission into a single thread, which in the last part of the apparatus is coated with a kind of waterproof varnish. As "silkworms," probably owing to the artificial conditions under which they are reared and in-and-in breeding, are subject to many diseases, especially about the period of pupation, attempts have been made to convert the viscous matter in the bodies of the caterpillars into silk by artificial means. But although the secretion can be drawn out into threads of considerable fineness, it resembles catgut rather than silk, and has no power of resisting the effects of water. A still more bold attempt has been made, namely, to obtain silk direct from the mulberry leaves on which the silkworm feeds; but this, as might have been expected, resulted in complete failure, many of the workings in nature's organic laboratories being too subtle for imitation by any of the means at man's disposal. It may be added that although silk of good quality is produced by silkworms reared in Britain, the thread is so short as to render it of little or no commercial value.

The best and most valuable silk is yielded by the white cocoons; but of these there are two descriptions, known in the trade as first and second white. The yellow cocoons, which are the most numerous, are divided into three classes according to size; the small and medium-sized cocoons being of higher value than the larger ones. The cocoons of other breeds vary in colour from greenish white to pure or reddish green; while there exists a Tuscan breed of silkworm which produces pale rose-coloured cocoons, and purple cocoons have also been reported. The breed yielding white cocoons, known in France as *sina*, appears to have been produced from the yellow-cocoon breed, by careful selection, since a certain percentage of yellow cocoons always appears among the white ones. By the exercise of great care the percentage of yellow cocoons, which formerly had been much larger, was reduced many years ago in France to a very few per thousand.

The silk-moth is the typical representative of a family of moths (*Bombycidæ*), characterised by the absence of a proboscis, and the presence of one internal nervure on the hind-wing. A second family of silk-producing moths—the *Saturniidæ*—differ from the *Bombycidæ* by the presence of two or three nervures in the hind-wing. Among these are some of the largest of all moths; and the majority of them are characterised by the presence of a clear transparent spot or "window" in the centre of each wing; the transparency being, of course, due to the absence on these areas of the minute scales which cover the remainder of the wings. Hence they may conveniently be called window-moths. The use of this very peculiar type of marking is at present quite unknown, but it is probably of some considerable importance in the economy of these insects.

In Japan the great silk producer is a large yellow window-moth, measuring nearly seven inches across the wings, known as the yama-mai (*Attacus yamamai*), the caterpillar of which feeds on oak-leaves. It produces large green cocoons yielding an excellent silk, second only in quality to that of the silk-moth. For a long time the exportation of this insect was forbidden, but eggs from time to time found their way to Europe, where attempts were made to acclimatize such a valuable species. All these attempts were, however, attended by failure. Although the cocoons are bright green, the silk in their interior is of a silvery white.

Another species which it has been attempted to introduce into France is the Manchurian window-moth (*Attacus perryi*), whose caterpillar likewise feeds upon the oak. Cocoons were first sent to Lyons, from which moths were in due course hatched out, and shown at the Paris Exhibition of 1855. The silk has some of the properties of wool and cotton, as well as of ordinary silk, and thus approximates to the Tusser (or Tusseh) silk of India, a name which is commercially applied to the produce of many of the window-moths. Of the true Indian Tusser moth (*A. mylitta*), which is found both in lower Bengal and the Punjab, the silk is perhaps even more valuable than that of the species last named. The silk is so coarse and knotty that it has to be carded instead of wound, and from it are made the well-known khaki-coloured tusser fabrics that are almost indestructible with fair usage. An excellent account of this moth and its silk is given by Mr. Cotes in an article on the "Wild Silk Insects of India," published in *Indian Museum Notes* for 1891, where mention is also made of other kinds of silk-producing species. Among these latter is the Atlas moth (*A. atlas*), which is one of the largest in the group. Its caterpillar is pale olive-green and lavender in colour, with a conspicuous D-shaped scarlet mark on either side of the hinder end. Like those of other members of the group it is armed with a number of spine-like warts.

The species that has perhaps attracted the largest amount of attention is, however, the ailanthus moth (*A. cynthia*), which is a native of Japan, where the caterpillar feeds on the ailanthus, or false Japanese varnish-tree. The wings of this handsome moth are ornamented by a conspicuous white line, externally to which is another band of rose; each wing also having a crescentic spot. This fine species was introduced into France in 1857 or 1858, where it has since been acclimatized, its food-plant flourishing well in that country. At first the cocoons could be made to yield by carding nothing more valuable than short-fibred floss-silk, but subsequently means were devised of obtaining long threads of an excellent description of silk. The ailanthus moth is found in China as well as in Japan. In India it is replaced by the closely allied castor-oil moth (*A. ricini*), which yields a silk of very similar character. By some writers this species is regarded only as a variety of the last. Darwin, in his "Animals and Plants under Domestication," states, for instance, that "the Arrindy silk moth (as it is often called) introduced from Bengal, and the Ailanthus moth from the temperate province of Shan Tung, in China, belong to the same species, as we may infer from the identity in the caterpillar, cocoon, and mature states; yet they differ much in constitution; the Indian form 'will flourish only in warm latitudes,' the other is quite hardy and withstands cold and rain." Apart from its tender constitution, the difficulty of cultivating the castor-oil plant, even in the south of France, offers an obstacle to the permanent acclimatization in Europe of the first-named form.

Omitting mention of certain other silk-yielding caterpillars, a few lines may be devoted to the subject of spider-silk. The gossamer-like nature of this delicate substance is familiar to all; and in fineness and tenuity the threads far surpass ordinary silk. From time to time more or less successful attempts have been made to utilize this substance; and recently a manufactory has been established in France where the ropes for military balloons are made from spider-silk. The factory is situated at Chalais-Meudon, near Paris. The spiders which supply the silk are arranged in dozens above a revolving reel, upon which the threads are wound; each spider furnishing from thirty to forty yards of thread. After the removal by careful washing of the reddish sticky outer layer, the threads are twisted into a yarn, which, although considerably more expensive, is both lighter and stronger than a cord of caterpillar silk of the same calibre. One of the chief difficulties connected with the manufacture is the feeding of the spiders.

The third and last description of silk used for manufacture is afforded by the *byssus*, or mooring-rope of the great mussel-like bivalve commonly known by its Italian name *pinna*, a word which properly denotes the fin of a fish, but is applied to the shell on account of its fin-like shape. The pinna, which grows to a length of two feet or more, is a semi-translucent shell shaped like an isosceles triangle; the byssus issuing on one side from between the two valves a short distance from the apex. This byssus consists of a silk so fine in quality as to produce a most delicate fabric when worked up. Although the supply of this pinna silk is too limited to be of any commercial importance, it has from time immemorial been manufactured into small articles of dress, such as gloves, stockings, and caps, at Taranto. Originally these were reserved for imperial or royal use, and at the present day are made rather as objects of curiosity than of use; the manufactured silk is of a delicate hair-brown colour. For some reason or other the pinna-silk is mixed with about one-third its bulk of ordinary silk previous to being woven. Some years ago the price asked for a pair of pinna-silk gloves at Taranto was six lire, while eleven lire were demanded for a pair of stockings. Specimens both of the byssus and of the manufactured silk are exhibited in the Natural History Museum at South Kensington.

In addition to its importance as the chief silk-producer of the world, the silk-worm also yields the finer descriptions of the substance known by the not very elegant title of "catgut." To obtain the catgut, or "gut," the silkworms must, however, be killed just before they commence cocoon-spinning, so that silk and gut cannot be obtained from the same individuals. Consequently the finer descriptions of gut, such as that used by the fly-fisher, are expensive.

The great manufactory of fine gut at the present day is situated on the island of Plocida, in the Bay of Naples, where, however, only a small proportion of the silkworms necessary for the manufacture are raised, the great bulk of these caterpillars being obtained from Torre dell Annunziata and other towns in the neighbourhood, where there are large silkworm-breeding establishments.

According to an account published a few years ago, the process of manufacture of "fili di seta" ("silk-threads") as the gut is locally termed, is as follows:—The silkworm is selected when fully matured, that is to say, at the moment when its nourishment ceases, and just before its metamorphosis. It is then cut open, great care being taken not to injure the membrane of the silk-glands there, which usually reach the length of thirteen to twenty mms., with a diameter of one and a half to two mms.; these are then removed, and put into a pickle, which is the keynote of the whole process, and the secret of which is carefully kept. When the pickling process is over, the work-people, who are mostly women, take one end of the gland in their teeth and draw the other end with their hands. This part of the work requires great dexterity, for the threads are drawn out to the length of from thirty to fifty cms., and the whole value of the product depends upon its length in relation to its thickness, and the strain it will carry. There are two seasons for the production, namely, in spring, when the best gut is produced, and in autumn, when the quality is inferior. There is an important market for this speciality, and the whole production is exported to Northern Italy and abroad at the average price of one hundred and fifty lire per kilo. The gut is of very small specific gravity, so that a great deal of it goes to a kilo. The cost of production is also considerable, since the silk-worms must be bought just at the moment when they are coming into profit for making silk, that is to say, when they are at their dearest. Again, the results are frequently disappointing, many of the caterpillars being found, on dissection, unsuitable, so that they have to be rejected.

THE USE OF HAND TELESCOPES IN ASTRONOMY.

By Cecil Jackson.

My object in writing these papers is to demonstrate the usefulness of hand telescopes even for astronomical work. Quite small pocket telescopes will do much interesting work; they are to the astronomical observer what the hand magnifier is to the microscopist. The instrument should, however, magnify not less than about ten diameters.

With such an instrument all the principal craters in the moon may be seen. The sunspots can also be observed, if care be taken to protect the eye from injury by using a dark glass. Should no dark glass be used, the sun must only be observed when largely obscured by fog. The disc of the planet Jupiter can be seen with a pocket telescope.

For the observing of planets it is sometimes desirable to remove one of the four lenses of the eye-piece. The lens next but one to the eye-end of the telescope is the one to be removed. The instrument is then to be used with the other lenses in their usual positions. After the removal of the lens, the magnifying power of the telescope will be found to be considerably increased, but only the centre of the now restricted field of view will be available for distinct vision.

A good way of holding a small glass is to grasp it between the fingers of either hand like a penholder, and then to rest the hand on some upright support. Steady yourself with the other hand after adjusting the telescope to your eyesight. In adjusting the eye-end for clear vision, do not push the draw-tube straight in, but twist it with a spiral motion. A very good way of holding a telescope quite steadily is to arrange the two sashes of a window, one just so much above the other that the telescope, when resting on them, is inclined at the proper angle for viewing any object you may wish to look at through the open window.

I.—THE MOON.

I shall suppose the observer to commence with the moon, and I shall now describe some of the objects visible on its surface, with the help of a three-draw telescope having a 1⅝-inch object glass and a magnifying power of from 25 to 35 diameters. A good 1½-inch telescope will bear a power of about 60 diameters, and a 2-inch land telescope a power of about 80 diameters.

Fig. 1 shows the moon when 3¼ days old at about 8h. 12m. p.m., June 27, 1892.

The largest craters shown in this sketch can, however, be seen with a smaller telescope if looked for closely, and the glass fixed or held quite steadily. A is Langrenus; B, Vendelinus; C, Petavius; D, E, mountains on the north and south boundaries of the Sea of Conflicts (Mare Crisium). These mountains may be seen as two lines of light projecting beyond the crescent moon.

Fig. 2 represents the moon at about 4h. 8m. p.m., Jan. 12, 1894. Moon's age, about 5d. 13h.

A—Theophilus, Cyrillus, and Catharine. This fine group of craters may be well seen with a 1½-inch telescope having a magnifying power of 25 or 30 diameters. Cyrillus and Catharine are connected by a striking valley; while Theophilus intrudes on Cyrillus on its north-west side. The western limb of the moon is the right-hand one as seen in a non-inverting telescope. B is a fine group of interlacing craters; the largest of which is called Janssen. This is a very

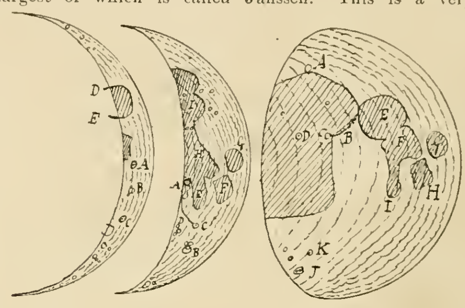


Fig. 1. Fig. 2. Fig. 3.

striking group when the moon is from four to five days old. In the late summer, or early autumn, these formations should be viewed when the moon is waning, about three or four days after full moon. The waxing moon is best seen from January to June, and the waning moon from June to December. C, Piccolomini; D, Altai Mountains; E, Sea of Nectar; F, Sea of Fertility; G, Sea of Conflicts; H, Sea of Tranquillity; I, Sea of Serenity. In the telescope, the "Seas" appear as vast plains. The boundary line between light and darkness ceases to be jagged where it crosses any one of these plains, thus proving that the lunar surface is comparatively level here.

Fig. 3 represents the moon as seen at about 8h. 20m. p.m., May 15, 1894. Moon's age, about 10¼ days.

A, Plato. This is a fine crater, of which the floor darkens towards full moon. Any good pocket telescope will show it. B, Lunar Apennines. This fine range of mountains presents a grand spectacle at about the time of First Quarter in the waxing moon, or about the beginning of the Last Quarter in the waning moon, when it may be seen as a line of light apparently projecting from the half moon into the sky. C, Eratosthenes. D, Copernicus, a splendid crater, and the centre of a streak-system in the full moon. E, F, G, H, I, Seas of Serenity, Tranquillity, Conflicts, Fertility, Nectar respectively. J is Clavius, a magnificent crater presenting a striking spectacle in an instrument magnifying 30 diameters, which will show it to have two craters on its floor, as well as two others adjoining its wall. The diameter of this object is 142 miles. K is Tycho, which is the centre of a wonderful streak-system, which can be well seen with a small telescope. One streak runs across the Sea of Serenity, E. Tycho itself is 54 miles in diameter, and has a central hill, well seen with a power of about 30 diameters.

THE CORONA ROUND THE SOUTH POLE OF THE SUN.

TOTAL SOLAR ECLIPSE, MAY 18, 1901.

From a Photograph with the Newbegin Telescope, at Mauritius.

THE POLAR RAYS OF THE CORONA.

By Mrs. Walter Maunder.

The corona of 1901 was of the most pronounced minimum type, its form was simpler than any of which astronomers have had experience since 1889. This circumstance, though it may seem to detract from its beauty and interest in some respects, is not without its advantages, as the relations of many of its details can be more distinctly followed and their significance better appreciated.

Especially is this the case with regard to the structures immediately round the two poles of the sun's axis. At times of maximum, the great synclinal rays are found, not merely in the neighbourhood of the sun's equator, but all round the limb, and the polar rays are obscured by the more conspicuous type of formation. But in an eclipse like that of last May, the polar regions are left absolutely free except for the beautiful and regular tufts of light which have earned for themselves the appropriate name of "plumes" or "panaches." These are then seen there in utmost distinctness, and can be studied to greatest advantage. No doubt structures similar in general character may exist in every region of the corona, both at minimum and maximum, but in the equatorial regions the greater brightness of the great synclinal curves, and the complexity shown by the regions of the corona close to the sun's limb, prevent the "plumes" from being easily recognised.

Restricting our attention for the present to the rays round the southern pole, they present something like the following appearance. Starting from the great south-east synclinal group, we find that the first polar rays are drawn over into a curvature which nearly, though not precisely, conforms to the southern outline of that formation. As we approach the pole the rays are less and less curved, till at the pole itself, and in its immediate neighbourhood, we find them as straight as if they were ruled. And this change of shape is not confined to the bright rays. Between the bright rays there are dark streaks—whether we regard them as mere rifts or interspaces, or as actually dark rays, having an objective existence, as being, in other words, an absorption and not a mere contrast effect—showing precisely the same excessive curving near the south-east synclinal group, and straightening gradually as they approach the pole until they become there as truly rectilinear as the bright rays amongst which they are found. Proceeding from the pole towards the west, we find in like manner that the curvature of the rays increases the further we get from the pole, although we do not get the same extreme bending noticed on the east. But it is noteworthy that the south-west equatorial wing is more diffused than the south-east; its outline is not so sharp and well defined, and the curve of that outline is much gentler, except at one particular point with which I am not at present concerned.

The dark rifts or rays interspersed between the bright polar rays deserve special attention. Many of these appear to be, and probably are, mere contrast effects, interspaces between the bright rays. But others seem to me to be of quite a different order. Thus on the east of the pole we find two bright rays, the curvatures of which lead them apart from each other the further they recede from the sun. The dark space between them therefore broadens the further we go from the limb. But within this space we find an intensely black line; not a contrast effect, for it borders neither of the bright rays, it does not broaden as it recedes from the sun, but is equally narrow throughout, and its curvature corresponds to that of neither of the bright rays between which it runs. More remarkable still it can be traced further from the sun than the bright rays. A similar remark applies to another ray even longer and darker than the first, that springs almost exactly from the sun's pole.

The polar rays towards the west appear to show some evidence that they are not in the same plane. To the extreme west two short bright rays of considerable curvature appear to be distinctly nearer to the spectator than a pair of straight rays which make a considerable angle with the solar axis. The more westerly of the pair would indeed seem to be partly hidden by the curved rays; the more southerly in its turn appears to conceal the lower portion of three straight rays, which show a slighter divergence from the solar axis. Elsewhere in the corona of 1901 there were similar indications, none very strongly marked, of a certain amount of relief. The general effect of this corona, as of all coronæ, is of that of an essentially plane phenomenon. The impression produced is that of a superficies, not of a solid; of a body having extension in two dimensions, not in three.

Yet we know for a certainty that the material composing the corona must be distributed in all three dimensions; taking one eclipse with another it must on the average be equally extended in all solar longitudes. We are looking down upon the sun day by day through a depth of the corona which on the average corresponds to its mean depth as seen in the tangential plane.

This consideration is so certain that it has led to the system of polar rays being regarded as in fact a sub-polar ring, the pole itself being bare. But at a distance from it of about 20° or 25° a number of rays rise from the surface and all of them bend over towards the sun's equator. On this theory, those rays which lay very nearly in the line of sight would necessarily appear to us to be straight or nearly straight, through the effect of foreshortening, and would be seen by projection in the apparent neighbourhood of the pole. It has been further suggested that this ring of rays would be a phenomenon essentially similar to our terrestrial auroræ, the long coruscations of which have frequently impressed themselves upon observers as resembling in appearance these polar rays of the corona. But indeed this latter suggestion is a very superficial one, and entirely ignores the difference between the positions of the spectator in the two cases. In the case of a terrestrial aurora we may indeed see the rays shooting up from low down in the north, high across our zenith, but we have no guide by which we can tell as to whether those rays are really rising or falling in our atmosphere, or as to whether, which is far more probable, they are moving practically at one given level; their apparent rise or fall being simply the effect of perspective. So far as our knowledge goes, a terrestrial aurora, watched from the moon, would seem to be essentially a surface phenomenon; as entirely so as the streaks which radiate from Tycho or Copernicus appear to be to us.

The difficulty which we have in regarding the polar rays as situated in a ring at about 65° of solar latitude lies here; that in such a case they should obviously be much more crowded together as we approach the greatest apparent distance east and west from the pole, whilst near the pole they should be considerably shorter and fainter, and much more sparsely scattered. In other words, not only would there be a marked flattening of the corona itself at the two poles, but the polar rays would show such flattening among themselves. But in general these features are just what are not seen. The straight rays close to the pole are in general at least as long and as bright as those nearest the synclinal groups, and they are nearly, if not quite, as closely packed. Yet a careful examination of the region before us does show a certain crowding towards the east, whilst close to the great dark ray at the pole a broad but short bright ray is clearly seen, which may very well have its rise in a latitude some 15° or 20° from the pole, either on the side of the sun nearer to us, or on that more remote.

The indications of relief in the corona, which the present plate affords, slight though they may be, are of importance, as they tend to remind us that the corona, in spite of that essentially flat appearance which it generally presents, must in reality have a great extension in the line of sight. It is a fact of which we need to be reminded, since it is so easy to forget it, and it has often been ignored in discussions upon its structure and nature. And indeed it seems very difficult to reconcile it with some features of its actual appearance. The dark rays, for instance, whether we regard them as mere interspaces between bright formations, or as having a distinct and separate objective existence, are exceeding hard to account for in a structure in relief. Then, again, in the coronæ of 1900 and of 1901, and we might add also in the more complicated one of 1898, the great mass of the corona was comprised in a very few striking formations of the character known as synclinal groups. In 1900, three of these were recognised, in the other two years, four. On all three occasions these structures had the most enormous extension, reaching on the average a distance of about three solar diameters from the centre of the sun. It is clearly not conceivable either that the structures which were visible were exactly where they appeared to be, in a plane at right angles to the line of sight, or that the moon concealed from us at the most more than two or three structures of similar character and extent. The picture, therefore, that is conjured up to our mind of what would be visible to us, could we look down upon the sun and see the corona on all sides at once and in full relief, is that of about half a dozen or so of these monstrous excrescences distributed irregularly round the sun; whilst about one-tenth of the solar surface, that immediately surrounding the two poles, would be given up to a few "plumes," few, that is to say, relatively to the area engrossed by them.

Letters.

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

THE SPECTRUM OF LIGHTNING.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The reproduction of a photograph of the spectrum of lightning on page 6 of the January number of this magazine is intensely interesting, and, so far as my experience extends, unique. I should indeed be glad to know how the hydrogen lines in that spectrum are to be accounted for. I presume that that element must for the time being exist in a free state in that part of the atmosphere in which a "thunder-storm" may be raging; but the question arises, How comes it there in sufficient quantity to thus indicate its presence? Are we allowed to assume that the passage of an electric discharge through a portion of the atmosphere decomposes the water-vapour therein into its constituents, oxygen and hydrogen; and that, further, the freed hydrogen is thus raised to incandescence and so made to manifest its presence? I should like to hear through some aeronaut if samples of our atmosphere have ever been taken at an altitude of from, say, one to two miles, which have been found to contain even ammonia in any appreciable quantity. Prof. Pickering remarks, in connection with the photograph under consideration, "A number of photographs were taken in this way, and showed the curious fact that the spectrum of lightning is not always the same." I do not just now see how they are likely to be precisely similar.

38, Burrard Road, William Godden.
West Hampstead, N.W.,
12th January, 1902.

RAINBOW BEFORE SUNRISE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Perhaps it may interest Mr. Johnson to know that I saw the same rainbow at Blackheath which he witnessed at South Croydon (*see* Knowledge, January, 1902, p. 11). I have a particular reason to remember the date, as I was going a few miles later in the day to see a relative in the country, and was rather anxious to learn whether it was also visible there, but could get no information on that point *à cause de la bonne heure*. The time during which I noticed the bow agrees with that by Mr. Johnson, from 7.15 to 7.30, and I remarked that I did not remember ever before seeing a morning rainbow in which the whole arch was so complete and of uniform brilliancy. W. T. Lynn.

Blackheath, January 1st, 1902.

HOAR FROST.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In Mr. Bell's interesting article on this phenomenon in Knowledge for November last two rather curious facts are not referred to. On calm frosty nights there is generally a slight air-current moving, and the direction in which it moves is always indicated by the position of the lines of ice-spicules, especially on the edges and corners of railings, walls, leaves, etc. One's first impression is that these lines of icy points are blown away from the wind and point down the current like flags. But the contrary is the fact. They are built up in the teeth of the current and point "up wind" to the direction from which it comes, like a vane. Such lines of hoar frost are often formed along the telegraph wires, and it is not uncommon to see the wires on such occasions curiously vibrating. The cause of this is a little puzzling, but I think it may be accounted for by a slight change in the direction of the current after the formation of the line of frost spicules. These spicules stand out like the teeth of a comb on one side of the wire only. If the current changes and now strikes them at an angle the pressure will cause a slight torsion of the wire until the resistance overcomes the pressure, when the wire will spring back and the same process will be repeated. F. T. Mott

Birstal Hill, Leicester,
December 17, 1901.

A POISONOUS SHRUB.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I hear, from the best authority, that there is an oak tree supposed to possess curious properties in the domain of the Earl of Annesley (Co. Down). For several years certain members of the family had suffered during autumn from a sort of skin eruption, and this season the symptoms were more pronounced, head and hands became swelled and inflamed, and feverishness supervened, the whole malady somewhat resembling erysipelas. It has been discovered that only those who touched the leaves of this oak were thus affected, and the secret cause of the complaint was definitely traced to irritation produced by handling them. We all know that the *Primula obconica* brings out a rash upon unwary admirers, but I had no idea that our sturdy old friend *Quercus* would act in the same way. Perhaps your readers could throw some light on the subject, and inform us to what species such an oak would belong?

C. MAUD BATTERSBY.

Cromlyn, Rathowen, Ireland,
November 19th, 1901.

[In reply to a request for information, Lord Annesley writes that the tree in question is *Rhus toxicodendron*. This is a North American shrub, belonging to a genus of which many of the species are highly poisonous. It belongs to the order *Anacardiaceæ*, and though called "Poison Oak," is in no way related to the true oaks, the genus *Quercus*. The member of the genus most familiar to British plant-lovers is the Staghorn Sumac, *Rhus hirta*, which is frequently seen in cultivation. R. LL. P.]

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

A MURDEROUS WATER RAIL IN LONDON.—On Sunday, December 22nd last, I was watching a Water Rail hunting for food in the rushes and patches of open water at the top of the Serpentine, which was frozen. There were some Sparrows about, one of which settled on some broken rushes near the Rail. The Rail immediately rushed at the Sparrow and seized it, apparently by the neck, in its long slender bill. The struggle which followed took them to a patch of unfrozen water, where the Rail "ducked" its victim and left it half-submerged on the edge of the broken rushes. The Sparrow died in about five minutes. Some ten minutes afterwards the Rail caught sight of the body, and going up to it gave it a few pecks, but did not attempt to eat it, so that hunger could not have been the cause of its strange action. On the following Friday I again saw the Rail in the same place; when it happened to get near the Sparrows it looked at them, but they were evidently frightened and flew up. The Water Rail must be rarely seen in London, and to find one acting in this extraordinary way seems worthy of notice.—F. R. RATCLIFF.

The Starling Roost on Cramond Island. By Charles Campbell. (*The Annals of Scottish Natural History*, January, 1902, pp. 2-9).—This is an interesting article on the flighting habits of the Starlings which roost on Cramond Island in the Firth of Forth. Starlings have roosted in great flocks for some years past in a small plantation of Scotch firs on this island, but it was not until the autumn of 1899 that they began to excite general attention in the neighbourhood. The result of the author's interesting observations may be summed up as follows:—The Starlings perform their daily journeys to and from the island with great regularity. No matter what the weather may be, and however strong the wind, they regularly perform their journeys across the Forth. They roost on the island in summer and in winter, although their numbers are lessened in the breeding season. No Starling remains on the island at any time of the year during the day. It is supposed that on their reaching the mainland in the morning the birds separate into small companies which have their particular feeding grounds. In the evening they gather together somewhere inland, and often pass over the Forth in one enormous flock.

Red-throated Pipit in Sussex.—At the meeting of the British Ornithologists' Club held on December 18th, 1901, Mr. Howard Saunders, on behalf of Mr. L. A. Curtis Edwards, exhibited a specimen of a Red-throated Pipit obtained at Ninfield, Sussex, on November 26th, 1901. It was in perfect plumage, and was evidently a young bird which had just completed its first moult. The Red-throated Pipit has been identified in Great Britain on very few occasions. For the cause of its apparent scarcity I would refer my readers to a note on the subject in KNOWLEDGE for September, 1901, p. 204.

Scops Owl in Kent.—At the same meeting referred to above a Scops-Owl was sent for exhibition by Mr. Collingwood Ingram. The specimen was caught alive in a coachhouse at Broadstairs in March, 1898. The bird eventually died and its skin was preserved. The Scops-Owl is only a summer visitor even to temperate Europe, and is seldom found so far north as the British Islands.

Waxwings in Scotland.—In the *Annals of Scottish Natural History* for January, 1902, it is pointed out (p. 52) that there has been a decided immigration of Waxwings to Scotland this winter, but though widely scattered over the country the birds have not come in considerable numbers. The Waxwing is somewhat capricious in its visits, which depend, no doubt, upon the severity of the weather on the Continent.

Great Snipe in Shetland and in Orkney (*Annals of Scottish Natural History*, January, 1902, p. 54).—There are few authenticated occurrences of the Great Snipe in Scotland. Mr. J. A. Harvie-Brown now records that one was shot on September 26th, 1901, in Shetland, while Mr. Robert R. Bell notes that two others were shot on September 25th, 1901, in Stronsay, Orkney. The Editors append a note that a further Great Snipe was shot near Castle Douglas during the past autumn.

Green Sandpiper in the Outer Hebrides (*Annals of Scottish Natural History*, January, 1902, p. 55).—A Green Sandpiper, a bird which has not previously been recorded from the Outer Hebrides, was obtained in South Uist during the past autumn.

On the Increase of the Starling and the Hawfinch. By H. E. Howard, F.Z.S. (*Zoologist*, December, 1901, pp. 463-467).—The author of this paper has found that the great increase of the Starling of late years, a fact which is universally admitted, has tended to drive away and cause a decrease in other birds which nest in holes of trees. In KNOWLEDGE for July, 1901, I pointed out how that the Starlings were driving away the Nuthatches especially, from the New Forest. Mr. Howard goes further and affirms that the Starlings evict even the Green Woodpeckers from their nests in his district. In my experience, however, the numbers of the Woodpeckers (which can bore nesting holes for themselves) has not been at all lessened by the increase of the Starling. I may add as a point of some interest that in the New Forest the Nuthatches return in considerable numbers in autumn and winter, and that the Starlings, which are now so numerous in the breeding season, forsake the Forest as soon as their young are fledged. Mr. Howard has also noted a large increase in Hawfinches, which he deplores from an economic standpoint owing to the great damage these birds do to fruit trees and vegetables. He traces the increase of both these birds to the growth of the human population and the consequent augmentation of orchards, market gardens, and other suitable feeding grounds. It might be suggested that the unusually mild winters and dry summers of the last few years should be taken into consideration as a possible important factor.

Yellow-billed Cuckoo (Coccyzus americanus) at Ringwood, Hants (*Zoologist*, December, 1901, p. 474).—Mr. G. B. Corbin records that a specimen of this American bird was shot at Ringwood, on October 30th, 1901. The bird was in perfect plumage, and showed no signs of abrasion in its feathers. For remarks concerning the occurrence of this and other American species *see* KNOWLEDGE, January, 1902, p. 16.

The Ringed-necked Duck as a British Bird (*Zoologist*, December 19th, p. 476).—Mr. O. V. Aplin here asks why this species *(Fuligula collaris)* of American Duck should not be included in the list of accidental visitors to Great Britain. The bird was originally described by Donovan in 1801 from a specimen obtained in Leadenhall Market, and said to have been shot in Lincolnshire. Mr. Aplin justly remarks that a hundred years ago no wildfowl came imported for the table from the other side of the Atlantic to London, but were not wildfowl imported for ornamental waters, and might not this bird have escaped?

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.—The discovery by Dr. Stewart of a new minor planet of more than average interest is announced by Prof. E. C. Pickering. A photograph, taken on August 14th last, revealed the presence of the planet, and later photographs showed that its daily motion was uncommonly large. A preliminary computation indicated that the planet was nearer to the sun than any other of its class at present known. Prof. Newcomb finds that the period is 4·13 years, the mean distance 2·57 that of the sun, the eccentricity 0·377, and the inclination 18° 38′. The new planet is now moving rapidly northwards, having crossed the equator about the 20th of January. Mr. S. B. Gaythorpe has drawn attention to the fact that the eccentricity of the orbit of the new planet is slightly less than that of Æthra—(132).

Continued investigations have established the reality of the changes in position of parts of the luminosity of the nebula surrounding Nova Persei, and explanations which aim at avoiding the seemingly impossible velocities which an actual translation of matter would require, are being put forward. Prof. Kapteyn and Mr. W. E. Wilson have independently suggested that the light of the nebula is reflected from the Nova, and that the apparent motion is nothing more than the progression of the light rays to nebulous or meteoritic matter situated at gradually increasing distances. On account of the vast distances of the nebulous matter from the Nova itself, it is supposed that the light of the original outburst may have taken months to reach it, so that the nebulosity did not appear until the star had greatly decreased in brilliancy. Sir Norman Lockyer has suggested that the luminosity of the nebula is produced by collisions of meteoritic matter, and that it is the loci of disturbances which are varying in position. A difficulty which presents itself is that the most prominent part of the nebula retained practically the same form during its movement. —A. F.

BOTANICAL.—Monsieur Laurent has an interesting paper in the *Comptes Rendus de l'Académie des Sciences, Paris*, of December 2nd, 1901, respecting the poisonous action of the mistletoe on certain varieties of pear, shown by the sudden dying off of the young branches during the heat of the summer. At the point of contact of berries, seeds, or young plants of the parasite with the bark of the pear tree, and even for several centimetres around it, the cortical parenchyma is killed and contracted, the vessels become choked up with gum, which interferes with the passage of the sap, in consequence of which the neighbouring leaves wither, and ultimately the branch dies. A single young plant of the mistletoe was found sufficient to kill a branch several years old. Though the poisonous principle resides in the pulp of the berries and in the seeds, it is most abundant in the young plants. The curious fact has been noticed that the mistletoe will not establish itself on some varieties of pear. This is shown to be due to the early death of the cortical tissue at the points where the seeds of the parasite germinate, and the young plants die before the haustoria can penetrate the bark of the host. Monsieur J. Chalon has observed that the mistletoe has a similar poisonous action on *Spartium junceum* and *Ficus elastica*.

Professor Matouschek, writing in the *Deutsche Botanische Monatsschrift* of December, 1901, mentions that an exceedingly fine female specimen of the yew growing in the village of Ungersdorf, Moravia, does not fail to produce its well-known fruits, though no male plant grows in the vicinity. On investigation he found that the pollen, which is conveyed to the female flowers by the wind, must have travelled upwards of five kilometres, the distance from Gaisdorf and Leipnik, where the nearest male specimens are met with.

It is well known that certain plants or parts of plants are difficult to dry satisfactorily. For instance, *Orobus niger* and many Scrophulariaceæ (*Pedicularis, Melampyrum*, etc.), which turn black during the process of drying, and flowers, which often lose their characteristic colours. Professor Rostowzew describes in *Flora*, 1901, Heft 3, two methods of drying botanical specimens, which have given excellent results. In that recommended for general use, pads of absorbent cotton about half an inch thick, and each wrapped in a sheet of tissue paper, are substituted for the ordinary drying material. The other method is termed drying plants on a metal cylinder, and is especially applicable to succulent specimens. Its salient features are a hollow metal cylinder, freely perforated at the sides, and covered at the top with a metal lid. The cylinder is tightly covered with a linen cloth on which the specimens, placed between layers of drying paper, are fastened. It is then stood on a tripod and a lamp applied at the bottom. The heat from the lamp will quickly expel the moisture from the specimens.—S. A. S.

ZOOLOGICAL.—Some months ago an article appeared in our columns on the manner in which Arctic mammals turn white. Important additional information with regard to the manner in which hair bleaches is afforded by a communication from Mr. E. Metchnikoff, recently published in the *Proceedings* of the Royal Society. It is there stated that the all-devouring cells known as phagocytes are the cause of the mischief. These cells, which frequently have amœba-like processes, are developed in the central or medullary part of the hair, whence they make their way into the outer or cortical layer, where they absorb and thus destroy the pigment-granules. Numbers of these phagocytes may be seen in hair which is commencing to turn white.

"The part played by phagocytes," writes the author, "in the whitening of hair explains many phenomena observed long ago, but not as yet sufficiently understood." Thus the phenomenon of hair turning white in a single night, or in a few days, may be explained by the increased activity of the phagocytes, which remove the pigment within an abnormally short period.

It appears from a communication published some time ago in our American contemporary, *Science*, that the California Fish Commission ordered the destruction of 10,000 sea-lions on the coast of that State, on account of the damage they do to the salmon fishery. It was expressly stated that the seals were not to be exterminated, but only a third of their number destroyed. Dr. C. H. Merriam points out, however, that 10,000, in place of representing a third of the number of these animals, probably exceeds the total. And he further points out that these sea-lions feed almost (if not quite) entirely on cuttles and squids, and do not touch fish. As Dr. Merriam observes, the fact that sea-lions in captivity will eat fish rather than starve, is no argument that they do so in their native state, when their stomachs are invariably found to be filled with the remains of cephalopods.

When the primeval ox of Europe ceased to exist as a wild animal, its name—aurochs—became transferred to the bison, and it is only of late years that it has been relegated to its proper owner. A similar transference of names has taken place in the case of the extinct South African blaaubok (*Hippotragus leucophœus*), whose title was long assumed by the roan antelope, of which a woodcut appears in Wood's *Natural History* under the former name. Of late years, however, the distinctness of the blaaubok has been fully recognised by naturalists; and Mr. Graham Renshaw, in the December number of *The Zoologist*, has done good service in collecting all the available evidence concerning the extermination of this interesting species, and in putting on record the specimens known to be still in existence. The blaaubok, it appears, was always restricted to a small area in South Africa, and appears to have been killed out in 1800. There are several mounted skins preserved in different museums, but none, unfortunately, in our own national collection.

At the meeting of the Zoological Society, held on 17th December last, Mr. G. Metcalfe expressed his opinion that naturalists are incorrect in stating that the Australian duckbill really lays its eggs. He believed, after many years' observation, that this remarkable mammal is viviparous, instead of, as generally believed, oviparous So far as we are aware, there is no published account of the eggs of the duckbill having been actually taken from the nest in the burrow; but the late Mr. J. D. Ogilvy in his "Catalogue of Australian Mammals" (1892) makes the definite statement that two eggs are laid there. Now that the question has been raised, it may be hoped that the matter will be thoroughly thrashed out.

The Zoological Society have sustained a serious loss by the death of their immature male giraffe, which took place on the ninth of January. This animal, which was purchased for a large sum in 1899, was afflicted with a "kink" in the neck, doubtless the result of an injury received at or about the time of its capture; the marvel is that it did not die at a much earlier date.

The following important message was recently received from Major Ross, now investigating malaria and other diseases on the West Coast of Africa:—"I have much pleasure in informing you that Dr. Dutton has made a very important discovery at Bathurst. He has found a new kind of parasite which causes fever in human beings. The parasite is like the one which causes the fatal tsetse fly disease among horses in South Africa."

An excellent idea in the way of zoological gardens has been started at Parà, Brazil, in connection with the well-known museum so ably directed by Dr. E. Goeldi. Instead of buying foreign animals, the plan adopted in these gardens is to collect only those inhabiting Brazil. By this means, not only do the people learn to know the fauna of their own country, but important information with regard to the same will almost certainly accrue to science. Among other animals, a manati has been exhibited.

In an important paper by Mr. W. P. Pycraft, recently published in the *Journal* of the Linnean Society, the author shows that the bony palate of the Ratitæ, or ostrich-like birds, differs essentially from those of the Carinatæ (we see no reason to follow Mr. Pycraft in changing these familiar names) in several very important particulars. It is also shown that the ratite type of palate (which also occurs in the tinamus) is the older. Hitherto it does not appear to have been recognized that the palates of all Carinatæ differ in one and the same particular from that of the Ratitæ, but this the author demonstrates to be the case. He also shows that the most primitive type of carinate palate is that of the fowls, and the most complex that of the ducks, owls, and certain other groups. This complex (desmognathous) type of palate, he suggests, may have been acquired independently in two or more groups of birds, and is not therefore indicative of genetic affinity. This paper is one of the most valuable contributions to avian morphology that has appeared for some time.

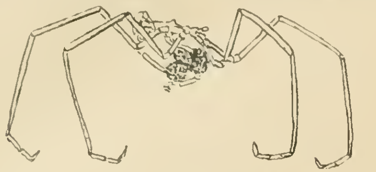
THE NOBODIES,—A SEA-FARING FAMILY.

By Rev. T. R. R. Stebbing, M.A., F.R.S., F.L.S.

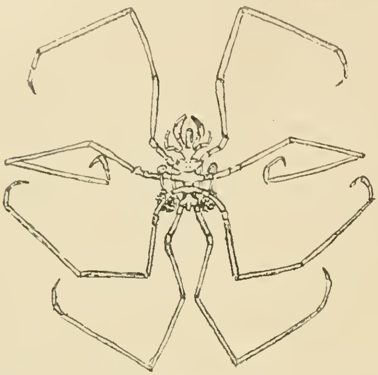
CHAPTER I.

Before boring out the eye, the solitary eye, of the stupefied Cyclops, Odysseus, in the Odyssey, took the precaution of stating that his own name was Outis, or Nobody. When the cruel cannibal, awaking to blind fury, shouted for vengeance, his neighbours were not a little mystified to hear that the outrage had been wreaked upon him by Nobody. They accordingly dispersed without attempting to catch Nobody, or put Nobody to death. Eventually, as we know, the so-called Nobody escaped by the skin of his teeth, and the story of his adventures has not ceased to fascinate the world during far more than two thousand years. In the economy of nature there occur bodies without limbs, bodies without apparatus for feeding, and occasionally limbs capable of detachment from bodies without loss of their own life and functional activity. But, strictly speaking, animals without bodies are unknown to zoology. All that can be said for the family now to be discussed is that they make an uncommonly good attempt to supply the deficiency. Socially we apply the term "nobodies" to persons who are unclassed, whose names never come before the cultured public, whose origin, qualities, and mode of existence are so little or so vaguely known that they neither attract the attention nor influence the thought of the world. In this sense also the group of marine animals now suing for notice justifies the modest title under which it is led on to the stage. Were it something absolutely novel, it might be brought forward with circumstantial pomp and a flourish of trumpets. It is too late for that now. Ström had a chance a hundred and forty years ago of exulting over his *Phalangium marinum* and *Phalangium littorale* as exceptions to the axiom that "there is nothing new under the sun." But he missed his chance by the very fact of assigning his discoveries to the genus *Phalangium*, thereby identifying them with the tracheate arachnids, popularly known as "harvestmen," a long-legged terrestrial tribe, peculiar indeed, but not new. That Ström was not able accurately to classify creatures, which had a familiar look of being honest harvestmen, but belied their looks by living in the sea or clambering about between tidemarks, was really not any discredit to Ström. A thin stream of highly capable observers since his time have busied themselves with the same creatures and their kindred. They have studied many species. They have founded numerous genera. They have assigned the whole group first to one zoological class and then to another with a persistency of irregular oscillation that no pendulum could imitate. The end of it all is very like the beginning, the result being that, place the group where you will in accepted orders, it is only by force and not by fitness that it can be pushed in. Such is the isolated and problematic position of the Pycnogonida.

It would be absurd to say that these animals are popularly known as sea-spiders, since there is really no popular knowledge concerning them. Vernacular names of



Nymphon marinum (Ström). Natural size. Lateral view.



Nymphon marinum (Ström). Natural size. Dorsal view. After E. B. Wilson *

this kind obtain a certain currency, because in regard to things strange and unaccustomed we are always longing to be able to speak and to hear every man in the tongue wherein we were born. But in the expression "sea-spiders" there is the special disadvantage that it prejudges a case which is still being argued. Though they are certainly not spiders, the question remains open whether their relationship to spiders is too remote to admit of their being grouped anywhere near them, or along with them at all, in the Arachnida. Their scientific name is properly derived from the earliest genus established in the group, *Pycnogonum*, Brünnich, 1764, and simply refers to a striking external characteristic, the "frequent angles" which their structure in general, and their limbs in particular, display. The Arthropoda, that vast division of the animal kingdom, which includes our present group along with Crustacea, Arachnida, Myriopoda, and the uncounted legions of the Insecta, are named from the common character of "jointed legs." In the Pycnogonida more uniformly than anywhere else is the significance of this name "arthropod" justified. For here the legs are the predominant structures in the organism, and their geniculations are as obtrusive and pertinacious as in any harlequinade. So decided is the prominence of the legs that in the early part of the nineteenth century Dr. Leach named the tribe Podosomata, meaning leg-bodied animals, and in the later part of the same century Gerstaecker and Dr. Anton Dohrn adopted for them the name Pantopoda, meaning animals that are all legs or nothing but legs. These designations, therefore, come to much the same thing as saying in English that the animals have no bodies. That, however, is by no means literally true, and accordingly there is no scientific warrant for displacing the earlier name Pycnogonida introduced by Latreille.

Dr. Dohrn in 1869, fresh from studying the group at Millport, in the island of Cumbrae, declared that, speaking generally, all English zoologists at that time considered it to be of crustacean nature, and that with equal unanimity all German zoologists referred it to the spiders. As a matter of history, then, it is worth while recalling that in the first volume of our English *Zoological Record*, which is the volume for 1864, Mr. Spence Bate writes of the "Pycnogonidae" as follows: "In adding this family to those of Crustacea, we do not consider that we are pledging ourselves beyond identifying it as a link that connects the Crustacea with the Arachnida. Although the result of recent research, both in the structure and development of these animals, tends to place them among the Arachnida, there are some points in their structure that associate them with the Crustacea; this, together with old association, induces us to speak of them in this place for the present." This old association may refer to the work of Johnston in 1837, and of Goodsir five or six years later, but Leach in 1815, in a famous contribution to the *Transactions* of the Linnean Society, most expressly includes the present tribe in the Arachnida, and Adam White, in 1857, excludes it from his "History of British Crustacea." Moreover, in the volumes of the *Zoological Record* the esteemed German writer, Dr. von Martens, who succeeded Spence Bate as recorder of crustaceans, followed his example down to the year 1874. There is, therefore, no such Anglo-Teutonic cleavage of opinion as Dr. Dohrn supposed. Much rather are two illustrious French authors mainly responsible for upholding the crustacean affinities of these spindle-shanks. For a long time the "Histoire Naturelle des Crustacés," by Henri Milne-Edwards, deservedly held the field as the only moderately complete, comprehensive, and trustworthy history of that class. During its reign there would have been few desirous, and still fewer effectively capable, of disputing the historian's opinion on an obscure issue which is thus expressed in his third volume (1840):— "It is only with much hesitation that I place here a little group of articulated animals which have been considered by most zoologists as belonging to the class of Arachnida, but which seem to me to have more analogy with the Crustacea, for they have no tracheæ nor lung-books for atmospheric respiration, and they do not appear to breathe the oxygen dissolved in water except through the general surface of the skin, as we have seen to be the case in several lower crustaceans." Much earlier, in 1816, Jules César Savigny, in his striking essays on Invertebrata, stoutly argued that, if the group were not actually crustacean, it was the link which most certainly connected that class with the arachnids. In those essays Savigny had at least one memorable success, namely, that which attended his homologizing, as it is called, the limbs of the Malacostraca. He demonstrated that the very organs, which in one set of them are parts of the mouth-apparatus and concerned with feeding, or, in one word, are jaws, in another set are prehensile or ambulatory limbs, answering to the description not of jaws but of arms or legs. One need not perhaps be surprised that he attempted to extend this discovery in other directions, and hoped to find in it a key for solving fresh problems.

Savigny was very well aware that in the Pycnogonida, when they are most fully furnished with appendages, there are never present more than seven pairs, whereas in the Malacostraca when fully furnished these pairs amount to nineteen, without counting the stalked eyes. This being so, he was under much of an obligation to compare a

* This species is commonly called *Nymphon strömii*, Kröyer; its identification with Ström's species being more or less conjectural.

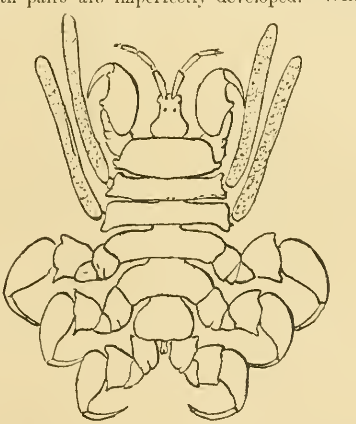
fully-furnished pycnogonid with a malacostracan not fully furnished. Yet to this convenient procedure he was led probably less by his own acuteness than by the odd behaviour of some earlier naturalists.

So long ago as 1675 the little amphipod, now known as *Cyamus ceti* (Linn.), which nibbles the skin of the Greenland whale, was described and rudely figured by one Friderich Martens, who evidently had in him the making of a good naturalist. Though vulgarly called a whale-louse, the *Cyamus* is as true a malacostracan as any crab or lobster. But it has its own features of distinction. Among the amphipods it belongs to that section called Caprellidea, which have so little of the roving disposition that they have found it convenient to dispense with pleopods or swimming feet. As a corollary to this act of abnegation they have reduced the pleon (or abdomen), which elsewhere carries the pleopods, to little more than a vestigial stump or reminiscence. On its head *Cyamus* carries a pair of simple eyes, and on its trunk or middle body instead of the normal seven pairs of legs it has but five pairs, the third and fourth having dwindled away to mere attachments for the branchiæ and the female brood-pouch. Now in 1765 Job Baster, a Dutch enthusiast on the botany and zoology of the day, called attention to this *Cyamus* in a singular manner. He was writing of fish-lice, and after remarking on the horror which many persons feel at the second half of that compound word, he adds that "a naturalist, on the other hand, who can never think it undignified to examine what God has not thought it undignified to create, finds tokens of the divine wisdom, power, and providence, as well in the despised louse as in the great elephant or rhinoceros." That is written in the spirit of a philosopher. But later on he makes particular observations which became the source of prolonged confusion. He describes and figures a pycnogonid, for some inscrutable reason introducing it as a whale-louse, though he does not pretend to say that he obtained it from a whale. Indeed, he recognises its essential distinctness from the original whale-louse described by Friderich Martens, but accuses Linnæus of having considered them one and the same. Linnæus, in his attempt to embrace the whole world of natural history, no doubt committed many errors, but this particular one was plainly out of his reach. The part of his tenth edition, in which according to Baster he made it, was published in 1758, while the Pycnogonida, as already explained, were not known before 1762. Still, as everyone is aware, Linnæus was a man of very obliging temper, and accordingly in 1767 he actually did commit the fault of which he was falsely accused in 1765. In his twelfth edition he makes Martens' whale-louse a synonym of Brünnich's *Pycnogonum* under the title of *Phalangium balænarum*, and this specific title is retained even in 1794 by J. C. Fabricius, although it had no claim to supersede Ström's earlier *littorale*, and although the Pycnogonida have nothing to do with baleen whales or any others.

Cyamus ceti (Linn.). After F. Martens.

Pycnogonum littorale (Ström). After Brünnich.

In whatever mistakes it may have originated, the coupling together of *Cyamus* and *Pycnogonum* made a comparison between the two a task as it were marked out and prepared for Savigny's hand. In the latter genus there are four simple eyes; in the former there are only two, but Savigny found in addition two compound eyes, which no other naturalist has seen before or since, and strangely enough the critics appointed to report on his essay, though evidently not at all disinclined to find faults in it, credit him with this imaginary discovery as something of considerable importance. For some reason he does not lay any special stress upon it himself. To compensate for this self-denial he makes the extraordinary observation that "Crustacea have not, properly speaking, any abdomen, and the Pycnogonid group are distinguished from other Arachnids by the length of their thorax and the extreme smallness of their abdomen." It is true that the Caprellidea have the abdomen singularly reduced, but in this respect they are exceptional not only among the Amphipoda but among all Malacostraca, and not only among them but among all free-moving crustaceans. To say that a lobster, for example, has no abdomen, so far from speaking properly, would be to make a statement as absurd as could well be devised. Savigny, however, was chiefly concerned to establish a parallel between the appendages of the trunk or thorax in the two animals under comparison. In an amphipod or isopod, the cephalic division or "head" carries six pairs of appendages. Then comes the trunk with seven pairs, which are all faithfully represented in *Cyamus*, though in a dorsal view the first pair are not seen, being concealed under the second, and, as previously mentioned, the third and fourth pairs are imperfectly developed. With this



Cyamus ceti (Linn.). Magnified. After Lütken.

state of things Savigny compared a species of *Nymphon*, in which he maintained that the cephalic part, or head, was constituted only by the proboscis, devoid of any distinct appendages, and that the seven pairs attached behind the proboscis answered to the seven pairs of limbs in the trunk of an amphipod. That in some of the Pycnogonida the first, the second, and in one sex the third, of the seven pairs may be wanting, is no impediment to Savigny's hypothesis, since in *Cyamus* also, two of the pairs have suffered degradation, and in both the compared groups abdominal limbs are, as a rule, conspicuous by their absence. But since the mainstay of Savigny's comparison is the numerical fact, that in each case the middle-body of the animal normally carries seven pairs of appendages, it becomes apparent that the comparison is definitely tied to the Malacostraca, among which alone that numerical arrangement is found. In the Malacostraca, however, there is no approach to a probosciditorm head, nor are heads to be found entirely devoid of appendages. Such a state of cephalic destitution does not occur even in the degraded parasitic isopods, and if it did, these as well by their life as their limbs are removed from comparison with the Pycnogonida. Again, the Malacostraca never have the eyes planted anywhere

Pycnogonum littorale (Ström). Magnified. After E. B. Wilson.

but upon the head. The eyes may be stalked or sessile, separate or united, compound or simple, or mixed of both, or they may be altogether absent, but they are never under any circumstances placed upon the thorax, which according to Savigny's interpretation is their position in *Nymphon* and its allies. The presence of external branchiæ, as found in the Malacostraca, in contrast to the total absence of branchiæ from the Pycnogonida, is set aside by Savigny as a difference of trifling importance. But the puny abdomen which is common to the Caprellidea and the Pycnogonida really narrows down the applicability of his comparison to the amphipods, since these are the only malacostracans among which the degraded abdomen occurs, and all these have external branchiæ on the thorax. The four hinder pairs of legs in the Amphipoda present numerous diversities of shape, but through them all they take care in their articulation never to exceed the limit of seven joints. With equal fidelity the Pycnogonida in their walking limbs take care to exceed that number. It would certainly seem, therefore, that from almost every point of view, Savigny's attempt to homologize the Pycnogonid limbs with those of the Crustacea, was a failure. It took its rise apparently from Baster's verbal mistake in calling a *Pycnogonum* a whale-louse, it was fostered by a certain superficial resemblance between two quite different animals, and it was developed through over-eagerness to make one triumph of ingenuity lead on to another.

From this historical and controversial discussion some facts relating to the structure of our "nobodies" will have been gleaned. There are rather singular details to be recounted hereafter.

Notices of Books.

"Man."—The most generally interesting item in the January issue, which commences a new volume, of this excellent anthropological journal, is an illustrated article by Prof. E. B. Tylor on a "totem-post" from Queen Charlotte Island, British Columbia, recently erected in the Pitt-Rivers Museum at Oxford. The post, in its present condition, is a little over forty feet in height, and is appropriately placed between two "house-posts," which came from the same village, if not from the same house. A photograph of the Haida village of Masset shows a row of these totem-posts (among them the Oxford specimen) before the chiefs' houses. "No more posts," writes Prof. Tylor, "are likely to be set up at Masset. Missionary influence has impressed on the native mind a sense of such art being a waste of labour." It is, therefore, well that this fine example has been secured in time. The exquisite coloured plate shows in detail the elaborate carving and colouring of the crown of the post; the "totems," or figures, being those of the family of its original owner. Other articles in the same number deal with the practice of altering the shape of the head among certain Pathans in the Punjab, Burmese pipes, Irish folk-lore, etc.

"The Earth's Beginning." By Sir Robert Stawell Ball, LL.D., F.R.S. (Cassell.) Illustrated. 7s. 6d.—Sir Robert Ball is always interesting, and not least so when he is lecturing to children. The present volume is the result of his juvenile lectures at Christmas, in 1899-1900, in the Royal Institution, thrown into book form, and form a popular exposition of Laplace's nebular hypothesis, in which Laplace's theoretical reasoning is touched upon very lightly, and more fully the evidence in its favour afforded by the photographs of nebulæ and star clusters, taken in America by the Lick and Yerkes Observatories, and in this country by Dr. Isaac Roberts and Mr. W. E. Wilson. The book is very fully illustrated, two of the pictures of Krakatoa, and of its effects on an English sunset, being highly coloured. We could have wished, however, that the pictures had not been printed in the text, but had been given as plates on separate pages, without printing or illustration on the back. The first paragraph suggests that Sir Robert had sat at the feet of Lord Rosebery when he gave his astronomical speech at Birmingham in October. Does Sir Robert really find from personal experience that "temporary concerns" (such as toothache or influenza) are forgotten in the presence of such phenomena as a spiral nebula, or in the contemplation of the solar evolution from the primeval fire-mist? And does Sir Robert really mean to give the impression that the nebulæ that Dr. Roberts has photographed in Pisces, or Coma Berenices, or Ursa Major, are such systems even as the Milky Way, only writ small since they are so distant from us and from it? Surely this is but the heresy of the "1500 universes" which Sir William Herschel described to Miss Burney as "whole sidereal systems, some of which might well outvie our Milky Way in grandeur," the heresy of which his later knowledge made him recant.

"Anticipations of the Reaction of Mechanical and Scientific Progress upon Human Life and Thought." By H. G. Wells. (Chapman & Hall.) Price 7s. 6d.—Of the many hundreds of books published in the course of a year, it is not often possible to name more than five or six which force themselves upon the attention of thoughtful readers of all classes. One of these select volumes from the literary output of 1901 is Mr. Wells's "Anticipations"; and we do not hesitate to say that no more vigorous and stimulating statement of human affairs and destinies has been published for some time. The author is best known perhaps by his fantastic stories, in which many scientific readers have found delight, and failed to find the paradox of the central idea. In this volume we have him as a philosopher, oracle, and prophet, who, surveying existing customs and social relationships, relentlessly points out the shams, pronounces the doom of stupid methods and conventionalities, and predicts the condition of things at the end of this century. It is impossible in the brief space which can here be devoted to the book to describe even in outline the social analysis and synthesis elaborated by Mr. Wells; but we can indicate the line of argument. Take, for instance, the subject of locomotion of the present and future. Now we have the crowded, slow, uncomfortable, unpunctual trains, which, in the case of London suburban traffic, traverse about twelve miles in an hour, and make it impossible for men with business in the city to live far out in the country. Leaving aerial navigation out of the question, it is suggested that the development of locomotion will probably be in connection with automobiles running on specially prepared tracks. Carriages of this kind will enable people to get out of town quickly, easily, and without the necessity of departing from one particular station and being carried to another, which may or may not be close to the desired destination. Horse traffic is a means of locomotion which is unworthy of an enlightened generation; for besides being inefficient, it is destructive and defiling to the streets. With the growth of motor tracks, the radius of a city will be greatly extended, and telephonic communication will enable all parts of the country to be connected for speech. Mr. Wells says nothing about automatic telephone exchanges or the possibility of telephony without intervening wires, but the changes he foreshadows will not be affected by developments of this kind. He is, in fact, more concerned with the effects of invention and increased knowledge upon the social organism than with future mechanical accomplishments. He predicts the downfall of Democracy and the creation of a New Republic in which the engineering and scientific class will exert dominant influence. The present order of things will pass away, and in the new heaven and new earth which Mr. Wells forecasts intellect will reign supreme. The author is no mere iconoclast, but an acute observer who examines the stream of tendency from many points of view and describes how use may be made of its flood. His conclusions will not be accepted by all students of human nature, but every reader of the book will be influenced by its forcible argument. Using the material available he establishes the New Republic about the year 2000, but knowing something of social inertia we suggest that two or three thousand years later would be nearer the epoch of the millenium. Mr. Wells' book appeals to every thoughtful mind, and, we believe, it will have a decided influence upon the trend of social evolution.

"Last Words on Materialism and Kindred Subjects." By Prof. Ludwig Büchner, M.D. With a life of the Author by Prof. Alex. Büchner. Translated by Joseph McCabe. (Watts.) 6s. net.—The title of this book is an unfortunate one. Prof. Büchner was not a materialist. He insists, again and again, in these essays that the system of thought he advocated is more accurately described as monism. The fact is there are no materialists. The beginning of the new century sees two opposing schools of thought; on the one side are the monists, with whom Ludwig Büchner would be found were he still alive, and on the other, are the dualists. Moreover, so long as the inorganic world alone is under consideration there is, to all intents and purposes, no difference between the monist and his opponent. When, however, the phenomena of life and consciousness call for explanation the difference between them is clear enough. The monist recognises no break between the inorganic and the organic worlds; the great principles of the conservation of matter and energy, and the other laws of physical science, are, he urges, as true of living things as any others. The dualist, on the contrary, maintains that satisfactorily to explain the organic world it is necessary to postulate a second cause, an effect of which when we come to study man, is found in his "soul." It is hardly necessary to remind readers of Knowledge that a large number of men of science are monists. As to the ultimate cause of all existence the man of science knows nothing, nor indeed does there seem any possibility of his knowing. Mr. Herbert Spencer has, to questions of this sort, given the name the "unknowable." But the great fact for practical men is that the "unknown" and the "unknowable" are by no means synonymous. With the triumphant march of science the "unknown" is every day having to reduce its boundaries, and this is incentive enough for the man of science. There has been in the past an opprobrium attaching to the name materialist, due probably to the uneducated advocacy of men who were concerned less with the advance of scientific knowledge than with the overthrow of dogmatic theology. The name might very well be allowed to die; and, if at the same time, those who find no need in the universe for any dualistic hypothesis are content simply to try to advance natural knowledge and to leave religious systems to take care of themselves, we shall be saved much useless controversy and have energy to spare for more important work. The world is fortunately beginning to understand that the practical matter of conduct is influenced much less by dogmas held on faith than was originally thought. To return to Mr. McCabe's translation, it is on the whole well done, though we think it is a pity that somebody conversant with technical terms did not revise the translation. Had this been done we should not have to call attention to such irritating mistakes as "phosphor" for "phosphorus" (pp. 41-2), "corbonic" for "carbonic" (p. 50), "sulphuretted antimony" (p. 32), and so on.

"Lectures and Essays." By the late William Kingdon Clifford. In two volumes. (Macmillan.) 10s.—The addition of these lectures and essays, first published in 1879, to the widely popular Eversley series will give the younger generation of students of science who are unfamiliar with Clifford's views, an opportunity of benefiting by these remarkably lucid expositions of fundamentally important subjects and of making the acquaintance of two beautifully produced volumes. As Sir Frederick Pollock says in a biographical preface, Clifford "expressed his own views plainly and strongly because he held it the duty of every man so to do; he could not discuss great subjects in a half-hearted fashion under a system of mutual conventions." He always discussed metaphysical and theological problems with exactly the same freedom from preconceived conclusions and fearlessness of consequences as any other problems. He always went to the root of matters under consideration. Taking as his subject ordinary questions of everyday life, on which all men ponder, he would so probe and analyse them that his hearers understood before he had finished that, having obtained clear views on the simple affairs of conduct and belief, they were well on the way to grasp all the philosophy that really concerned them. "Body and Mind," "Right and Wrong," "The Ethics of Belief," are examples of the questions that Clifford loved to explain to intelligent audiences. "The domain of science," he said on one occasion, "is all possible human knowledge which can rightly be used to guide human conduct." No bounds must be set to the "purifying and organizing work of science." It is not surprising that so fearless a thinker and so brave a prophet was often disliked and dreaded. Naturally, the doctrine that "it is wrong in all cases to believe on insufficient evidence; and where it is presumption to doubt and investigate, there it is worse than presumption to believe"—did not endear Clifford to official theologists. But the more intelligent views which are common to-day are to be traced to men like Clifford, who, regardless of what pleased this or that sect, preached truth for truth's sake, and maintained that all truth is the heritage of humanity and must not be withheld because priests and church officials say the masses cannot bear it yet. The young student of science, nurtured in orthodoxy, who is finding himself in pain and travail as he first applies the scientific method to the dogmas he was taught in childhood, should read and study these essays. Here are the words of a master who has passed along the same road, who though he discarded many of the myths of the infancy of the race, never lost his grasp of the great ethical and moral principles on which the social welfare of mankind will always depend.

"Studies in Heterogenesis." By Prof. H. Charlton Bastian, M.A., M.D., F.R.S. First Part. Illustrated. (Williams & Norgate.) 7s. 6d.—The conclusions arrived at by Prof. Bastian are so opposed to the teachings of modern biologists that we cannot but be surprised at their enunciation by a Fellow of the Royal Society. The thesis which he endeavours to establish is, in general terms, that from one presumably pure substance of an organism it is possible to produce various alien forms of life. In support of this view, among other observations described and illustrated, are the transformation of the contents of vegetal cells and organisms into such forms of life as amœbæ, actinophrys, and monad cysts; of the substance of certain encysted ciliates into amœbæ and monads; and of the substance of the eggs of certain rotifers into primitive fungoid sporangia and ciliated infusoria. The natural interpretation to put upon the observations would be that the changes described are due to the multiplication of forms of life of which the germs existed in the original substance, or which invaded it. Prof. Bastian has considered this interpretation but has rejected it in favour of the conclusion "that the resulting forms of life are, in reality, heterogenetic products originating from the very substance of the organisms or of the germs from which they proceed." Such a heterodox opinion is not likely to be accepted upon the evidence he brings forward, but to disprove it would be as difficult as it was to overthrow the doctrine of spontaneous generation. The subject can only be dealt with adequately by biologists trained in the exact methods used by Pasteur and his followers, and we believe they would object to the conditions under which many of the observations were made.

"A Ready Aid to Distinguish the Commoner Wild Birds of Great Britain." By David T. Price. (Gurney & Jackson).—In this little book the author has made a poor attempt to carry out an idea which would be of value if it could be successfully accomplished. Mr. Price begins with a sort of key by which on seeing a bird in the garden, field, or wood, one is supposed to be able to judge its species. For this purpose a much more exact and more wisely arranged key than that devised by the author would be necessary to lead to a correct identification. Having discovered, by the key, the supposed name of the bird seen, we are referred to a brief description of it in the second part of the book. Here Mr. Price has come sadly to grief regarding many species. His idea has been to deal with "habitat, flight and characteristic habits rather than details of plumage." Then why does he not, for instance, differentiate the brown and barn owls by their distinctive notes rather than by the colour of their plumage, which is seen rarely when they are abroad? Some of the author's descriptions are very good, and in these the correct characteristics in habits or plumage which will lead to identification have been pointed out. But Mr. Price is evidently a poor observer, and in many instances shows a lamentable want of knowledge of his subject. He says, for example, that the cock house sparrow has a red-brown cap, and surely of all birds the familiar sparrow could have been described correctly. That the red-brown cap belongs to the tree-sparrow, and is one of its distinguishing marks is not mentioned. Again the plumage of the wheatear is described as pale brown. The female wheatear, and even the male in early winter, may be so described, but the conspicuous and beautiful grey of the cock bird in spring and summer is not referred to. Nor do we think the author's selection of the commoner birds altogether wise. The guillemot, for instance, is described; but the razor-bill, which in winter, in any case, might easily be mistaken for it, is ignored.

BOOKS RECEIVED.

Text-Book of Elementary Botany. By Charlotte L. Laurie. (Allman & Son.) Illustrated.

Experimental Chemistry. By Lyman C. Newell, PH.D. (Heath.) 5s.

"Stops": or How to Punctuate. By P. Allardyce. (Fisher Unwin.) 1s.

Britain and the British Seas. By H. J. Mackinder, M.A. (Heinemann.) Illustrated

Lamarck: His Life and Work. By Alpheus S. Packard, M.D., LL.D. (Longmans.) 9s. net.

Concise Dictionary of Egyptian Archæology. By M. Brodrick and A. Anderson Morton. (Methuen.) Illustrated. 3s. 6d.

Mosquito Brigades and How to Organise Them. By Ronald Ross, F.R.C.S., D.P.H., F.R.S. (George Philip & Son.) 3s. net.

Guide to the Practical Elements of Electrical Testing. By J. Warren. (Rentell.) Illustrated. 3s. 6d.

Practical Electrician's Pocket Book and Diary, 1902. (Rentell.) 1s.

French History, 1815–1873. By Henry Hirsch, B.A. (Blackie.) 1s. 6d.

History of Geology and Palæontology. By Karl Alfred von Zittel. Translated by Maria M. Ogilvie-Gordon. (Walter Scott.) 6s.

In Memory of W. V. By William Canton. (Dent.) 3s. 6d. net.

Discussion on the Teaching of Mathematics. (British Association.) Edited by John Perry. (Macmillan.) 2s. net.

Annuaire Astronomique et Météorologique pour 1902. By Camille Flammarion. (Paris: Ernest Flammarion.) 1 fr. 25.

Underground Watering of Plants and Gardens. By John Grant. (Ward, Lock.) 1s.

Bird-Killing as a Method in Ornithology. By Reginald C. Robbins. (Cambridge, Mass.: Wheeler.)

THE FLIGHT OF A HAILSTONE.

By Arthur H. Bell.

A hailstone, when dissected, is found to be an aggregate of tiny crystals disposed in concentric rings or zones; zones which, if rightly cross-examined, will have much to tell concerning the wonderful journey of the hailstone as it plunged through the atmosphere on its way to the earth. A snowflake makes this same journey through the air in a more leisurely fashion, and it does not arrive at its destination with the noise and rattle that announces the descent on the earth of hailstones; but the two travellers are very nearly related, for they are both the offspring of aqueous vapour. It is part of the work of the meteorologist nowadays to discover, if he can, why the moisture in the air sometimes takes the form of a snowflake, while at others it crystallizes as a hailstone. To merely record the size of a hailstone is insufficient, for these frozen pellets of moisture have more interesting attributes.

At the heart of every hailstone is a tiny atom of dust, which may be considered to be the very foundation of the whole icy structure. These atoms of dust pervade every part of the atmosphere. Not only are they found in the lower strata of the air, but the winds carry them far above the highest mountains, and no matter whether samples of air obtained by balloonists or by mountain travellers are examined, minute particles of dust are always everywhere to be found. Indeed, it is becoming understood that without an atom of dust upon which the moisture of the air could settle there would be no rain-drops, no snow, no fog, dew, clouds or hail. Without these minute platforms, as they may be called, upon which the moisture as it condenses could alight, rain would be continually pouring down upon the earth, and it is these motes that keep the moisture buoyed up in the atmosphere until such times as circumstances compel them to yield up the aqueous supplies which they so industriously collect. Supposing, then, that a little vapour should happen to condense on a particle of dust floating aimlessly through the air, there is a beginning made of what, under favourable conditions, may ultimately grow to a full-sized hailstone.

It is highly probable that, for a hailstone to have fitting opportunity of growing to maturity, it must take its plunge to the earth from a great height. The clouds which float at the greatest distance from the earth are those known as the cirrus, which are often seen many miles above the tops of the highest mountains. If, then, an incipient hailstone can only dive towards the earth from this dizzy height it will in its headlong flight pass through strata of air differing very much as regards moisture and temperature, and these are the circumstances most favourable to its development.

But before the growing hailstone can launch itself downwards it must by some means or other contrive to get itself carried up to these serene and chilly heights. Briefly, it makes the journey by stepping, as it were, into one of the strong ascensional currents of air which spring upwards from almost every part of the earth's surface. These currents are revealed by the cumulus clouds which are but the visible tops of columns of air. As these rising currents of air rush upwards they presently arrive at a height where the air is rare and cold, so that the aqueous vapour they carry with them condenses and promptly assumes the form of a cloud; a process that may be likened to a rocket which bursts into a visible cloud of fire at the end of its upward flight. If, then, the dusty atom with its tiny load of moisture that is subsequently to form the nucleus of a hailstone can succeed in entering such a rising stream of air it will ere long find itself at a height that will ultimately prove to be an admirable coign of advantage. In this position it resembles nothing so much as an oak apple dancing at the top of a jet of water, for in each case an ascending current keeps the object buoyed up.

But it often happens that yet loftier heights are necessary for the growth of a hailstone. Supposing, then, that a further upward flight is desirable, there is a convenient motive force ready to hand. It is well known that whenever condensation of moisture takes place latent heat is set free, so that when the aqueous vapour is actively engaged, say, in condensing into the form of a cloud, it is probable that great supplies of warmth spring into being. This warmth, of course, raises the temperature of the air, and as the latter becomes warmed it rises and another form of ascending current is thereby produced. Such a current provides the hailstone with a means of conveyance to those exalted regions it is so advantageous to reach. Probably at the end of its long journey the incipient hailstone will be far up in one of the cirrus clouds, surrounded by particles of moisture frozen by the cold rarefied air into ice crystals, so that in its new situation the hailstone would find ample supplies of the material so necessary for its growth.

In such company it is not long before the moisture on the atom of dust also freezes. The form which the frozen moisture will take depends on circumstances, but there are many possibilities before it. Thus it may crystallize as a tiny pellet of snow, or it may take the shape of an ice crystal, or it may commence as a snow-flake; while in certain circumstances it will simply take the form of a frozen rain-drop. Any of these shapes will serve as an excellent starting point from which to commence the earthward journey.

During all the time of its upward journey the force of gravitation has been steadily pulling at the rising atom of dust and its load of moisture. Few things floating in the air can long resist this imperative call to return to the earth.

Falling slowly downwards, the motion being slow at first because the bulk of frozen moisture is small, the hailstone at once commences to attract to itself other particles of frozen moisture. These adhere to it much in the same way that snow-flakes will adhere to anyone travelling quickly through a snow storm; so that as the hailstone pushes its way downwards it grows in bulk. Moreover, as its weight increases it may happen that its centre of gravity shifts, and it becomes accordingly of an irregular shape. This accident indeed accounts for many of the curious shapes assumed by hailstones and gives them that peg-top shape which is so often observed. It is to be remembered also that a hailstone takes a long time to drop from the clouds to the earth, it being calculated that the journey may often occupy ten minutes. In this interval most of the transformations occur that produce the full-grown hailstone.

Imagining now the journey to be well started it will at once be realised that the travelling hailstone will pass through strata of air that differ very much as regards temperature and moisture. Some of the air will be above the freezing point and other layers will be below it; while it will be no uncommon episode for the dropping hailstone to plunge sheer through a cloud that may be many thousands of feet thick. The hailstone itself, with its heart of ice, is always below the freezing point, so that any moisture that settles on it is promptly frozen and forms a girdle of ice around the central nucleus. An examination indeed of any hailstone shows that these icy girdles are its most characteristic feature. It will also be observed that these girdles or zones are of two kinds, and that they are alternately clear and opaque. It is these zones that tell the most concerning the incidents of a wonderful journey, for they are produced by the different strata of air through which the hailstone passed, each country, as it were, over which the journey was made impressing its characteristics on the flying traveller.

When the hailstone passed through air that was below the freezing point the moisture that settled upon it was frozen in the form of a clear zone of ice; while, on the other hand, when the air and its contained moisture were above the freezing point the girdle of ice was opaque.

A further important consideration as regards the hailstone is that moisture may often be reduced in temperature below the freezing point without actually congealing. It is a common experiment thus to treat moisture, but it is always found that the slightest agitation of this cooled liquid at once causes it to crystallize. When, therefore, the hailstones come pelting through air in this condition it will readily be understood that the commotion produces a plentiful supply of ice crystals, many of which are quickly annexed by the hailstones, which are thereby greatly increased in size.

The foregoing are the most common conditions that favour the growth of a hailstone, and it will be concluded that the essential conditions required are layers of air of different temperatures. Now it frequently happens that hail accompanies a thunderstorm or a tornado; these two phenomena being very nearly related. In both there is an atmospheric whirl, which, in the tornado, produces a strong wind that is commonly of a destructive character. If, then, a hailstone should be going through its evolutions in the neighbourhood of one of these storms it stands a good chance of being whirled round and round in the air, a process that may continue for a considerable time. This violent treatment, however, has the same effect as if the hailstone were falling downwards through the air, and the result is that it may be carried again and again through first a cold stratum of air and then through a warm one. As already seen these are the very conditions that favour the growth of hailstones, and hence it is that hail so commonly accompanies thunderstorms, tornadoes, and such like atmospheric disturbances.

The whirling of hailstones through the air cannot, however, continue indefinitely, for presently they grow so heavy that they fall in a rattling stream from the edge of the cloud. Observation shows that hail showers often pass across the country in parallel lines; but it will be gathered that this is owing, as described above, to the fact that the stones are ejected from the sides of the storm cloud and not so much from its centre. Hailstorms, as a rule, are not of a very large area, and are much longer than they are wide. The width is regulated by the dimensions of the cloud, the length being governed by the distance to which the internal energy of the storm urges the storm-cloud forward.

Hail occurs more frequently during the day than in the night, and in summer than in winter. It also falls more copiously over the land than over the sea, where it is but rarely observed. Hail, indeed, is a turbulent child, and it does best in those localities and at those seasons when the atmosphere is in a variable mood. At such times the cross currents in the air produce those eddies which are the most favourable for the growth of storm-clouds, out of which leap the tornado and the thunderstorm. Plains also are more often visited by hail than mountainous regions, for here again the atmosphere is more likely to be in an unstable condition because such exposed ground often varies greatly in its temperature. Hail, moreover, is rarely met with in the Arctic regions, thunderstorms being equally rare in this locality. It is this circumstance, among others, that has caused some people to give atmospheric electricity a prominent position in relation to hail formation, and more especially so because lightning and hailstorms frequently occur together. Caution, however, is always necessary when putting electricity forward as a cause, for to do so is often to explain one mystery by another. From what has been said it will be gathered that there are simpler explanations of the flight of a hailstone, and it is along these more obvious lines that the history of this interesting phenomenon is nowadays being studied.

COLLECTING AND PREPARING FORAMINIFERA.

By A. EARLAND.

(*Continued from p.* 21.)

THE residuum which had been set aside in a jar may now be treated by the "rocking" process, for the separation of the remaining Foraminifera. Taking the photographic developing dish, or a tin tray may be used as a substitute, enough of the residuum is placed in it to cover the bottom to a depth of about ¼ inch, and covered with about ¾ inch of water. If the dish is then rocked with a combined up and down and circular motion, the Foraminifera will rise in suspension in the water, and by a little careful manipulation may be gathered in one corner of the dish. A sudden tilt will then empty them with the water into a sieve. The operation should be repeated with two or three lots of water, and the material left in the dish will then be found to consist almost entirely of sand. The material left in this second sieve, known as "washings," is not so pure as the "floatings," for it contains a large percentage of broken forms and shell fragments, coal dust, and other *débris*. It may be further purified, if desired, by being dried and "floated" once or twice in the glass jar.

If the floatings thus obtained contain much animal or vegetable matter, as is sometimes the case, it is advisable to boil them in a solution of caustic potash. This will not damage the Foraminifera so long as the boiling is not carried on too long, and it effectually removes the animal matter, which otherwise would encourage fungoid growths.

The processes already described are intended for recent *sandy* gatherings. When the material is in the form of dredged mud, it is first necessary to get rid of the finest particles of this mud, for if the water is turbid it becomes very difficult to judge the right moment for separating the floating Forams. The mud should be broken up into small lumps, about an inch cube, and slowly but thoroughly dried. It is then placed in a basin and covered with water, which rapidly breaks it up into a fine mud. Such specimens as may be observed floating on the surface of the water may be easily removed by means of cigarette papers, which are placed on the surface of the water. The Forams adhere to the papers, which are then carefully lifted off and dried, the Forams being then brushed off into a tube. Many delicate forms, which would almost certainly be broken in the subsequent processes, may thus be obtained in a perfect state.

The mud remaining in the basin is then washed, a spoonful at a time, by placing it in a sieve of fine silk gauze, through which a gentle stream of water from the tap is kept running until all the fine particles have been removed. The muddy water should be allowed to settle in a bath, and the solid residuum then scraped out and thrown away. The sandy residuum left in the sieve should then be thoroughly dried, and is then ready for examination under the microscope, or if desired it may be further purified by the floating and rocking processes already described.

Foraminifera occur in marine fossil deposits of all geological ages, from the Cambrian to Post Tertiary deposits, but they are, as a rule, of sparing occurrence until we reach the Cretaceous period. The harder chalks and limestones can only be studied by means of thin sections, but the softer chalks, shales, and clays may be broken up by drying the material in small pieces, and washing it over a fine sieve in the manner just described. Floatings are seldom procurable from fossil deposits owing to the weight of the specimens, which are generally more or less infiltrated with pyrites or other mineral matter.

Some chalks and shales which resist the disintegrating action of water after being dried may be broken up by the action of a crystallising salt, which has been absorbed in a fluid state. Acetate of soda has the most rapid action, but very fair results may be obtained with common washing soda. The material after being broken up into small pellets is dropped into a boiling saturated solution of the salt, and kept at this temperature for a short time to allow of penetration. The salt is then allowed to cool, and in cooling crystallises, the formation of the crystals breaking up the outer layer of the material. On being warmed the soda dissolves again in its own water of crystallisation, and the crystallisation is repeated over and over again until the lumps are broken up. The resulting mud is then washed in the ordinary way.

The best Foraminifera from the chalk are those obtained from the interior cavities of hollow flints. They are often in the most perfect state of preservation, and the chalk in these cavities being of a powdery nature, they are very easily cleaned.

The cleaned material should be sifted into varying degrees of fineness, and each grade kept separately in a tightly corked tube, noted with locality, date, and any details as to the species contained in it, which may be likely to be useful for future purposes of reference. If the material has been properly cleaned and dried it can be kept unaltered for an indefinite period, but if put away damp, fungoid growth will quickly set in. This can be destroyed, and the material sterilised, by a prolonged soaking in spirit, the material being afterwards dried once more.

To examine the material under the microscope a picking-out tray will be necessary. This is made by covering a slip of card with coarse black ribbed silk, the ribs running longitudinally along the slip. A thin wooden ledge must be glued round three sides of the slip to prevent the Forams rolling off when the stage of the microscope is inclined at an angle. The material is sprinkled over the slip, and the ridges of silk keep the Forams from rolling about. The specimens required can then be easily selected by means of a fine sable brush, moistened by drawing it between the lips, and transferred to a prepared cell or slip.

The best fixative for mounting Foraminifera is gum tragacanth, which is almost invisible when dry, being quite devoid of the objectionable glaze which characterises gum arabic. It is also much less subject to variations of moisture than gum arabic, which alternately contracts and expands with changes of weather, and often fractures delicate forms. Powdered gum tragacanth should be used in the preparation of the mucilage. Put a small quantity of the powdered gum in a bottle with sufficient spirits of wine to just cover it. Add a small crystal of thymol or a few drops of clove oil, or oil of cassia, as an antiseptic, then fill the bottle with distilled water and set it by for some hours. The gum will form a thick mucilage, and may be used of varying thicknesses according to the size of the Foraminifera. For most forms it should be of about the consistency of cream, and it may be used liberally in mounting, as it shrinks very much in drying.

The same gum diluted to a watery consistency can be used as a fixative for Foraminifera mounted in balsam. If the slide is thoroughly dried before the balsam is added the gum becomes quite invisible.

For very large and heavy Foraminifera, seccotine or some other liquid glue may be used with advantage, gum not being of sufficient strength to hold them safely.

Many fossil Foraminifera and recent forms from some localities have the internal chambers filled with mineral infiltrations, either glauconite or pyrites. These internal casts reproduce more or less perfectly the shape of the sarcode body of the animal. They may be obtained by decalcifying the specimens with very dilute nitric acid, just faintly acid to the taste. To obtain perfect casts the process must be carried out very slowly, adding drop by drop to the watch glass containing the specimen. When decalcification is complete, the resulting cast should be carefully removed with a pipette, and deposited in a spot of gum on a slip. They will not stand transference with a brush without damage.

NOTE.—*For particulars regarding the Distribution of Material, see below.*

Conducted by M. I. Cross.

POND COLLECTING MONTH BY MONTH.—Mr. C. F. Rousselet has arranged to provide for each month a list of the material that should be looked for and likely to be found at that period of the year:—

POND-LIFE COLLECTING IN FEBRUARY.—In the early part of the year when the weather is still cold and ponds are covered with ice, some Infusoria may be found in abundance, particularly the various species of Vorticella—*Carchesium polypinum*, *Zoothamnium arbuscula*, *Epistylis flavicans*—attached to submerged rootlets.

Rotifera to be looked for in lakes and ponds, particularly duck ponds.—*Anuraea aculeata*, *Anuraea cochlearis*, *Asplanchna priodonta* and *Brightwelli*, *Notholca scappa*, *Polyarthra platyptera*, *Euchlanis deflexa*, *Synchaeta tremula*. The water plants having mostly died down, the following fixed forms are found attached on Anacharis or on submerged rootlets of plants, or of trees growing near the edge of ponds and lakes:—*Melicerta ringens*, *Limnias ceratophylli*, *Stephanoceros eichhornii*, *Floscularia cornuta* and others, *Oecistes crystallinus* and others.

TWO-SPEED FINE ADJUSTMENTS.—At first sight a proposition that a microscope should be provided with the equivalent of two fine adjustments, by means of which both an extremely slow and a rather more rapid movement might be imparted, in addition to a well-fitted coarse adjustment, would seem to be scarcely worthy of discussion. Consideration leads one to believe that it might occasionally be convenient, but actual working with the fitting itself puts the whole question beyond speculation.

Any mechanical contrivance which enables those who have to work rapidly to attain their results with increased facility is worthy of commendation, and its virtues should be made known.

An interesting paper by Mr. Ashe, with illustrations of the methods of application of two-speed fine adjustments, appears in the *Journal of the Quekett Microscopical Club* for November. Reichert, of Vienna, had already anticipated the idea by incorporating a similar arrangement in his large model microscope, but Mr. Ashe has rendered practical the fitting of the device to direct-acting screw fine adjustments of the Continental type, and, in conjunction with Messrs. R and J. Beck, has neatly contrived a manner of applying it to such instruments as have a fine adjustment, worked by a lever in the limb.

It consists of two concentric milled heads, working respectively coarse and fine screws, the former being controlled by the upper milled head, and at its point making contact with the lever. This operates through the lower milled head, which works on the fine thread, so that without real thought the fingers can move from one milled head to the other as a quick or slow motion may be required.

As a two-speed adjustment can be fitted to different classes of microscopes subsequent to manufacture, it is likely that many workers may feel disposed to have it experimentally added to their instruments.

INCREASING EFFECT WITH THE ABBE ILLUMINATOR.—The Abbe Illuminator has for some time been regarded as such an inferior condenser for all who aspire to accurate work, that little devices which might render it more efficient have been often overlooked. When the enormous number of them that are in use in all parts of the world is taken into consideration, every hint regarding them is of importance.

When the edge of the flame is focussed with an Abbe Illuminator and the back lens of the objective examined through the tube of the microscope, the black spots, which indicate the limit of aplanatism, appear when the iris is but slightly opened. If, however, the flat of the flame be used and carefully focussed, a much larger iris opening can be employed before the black spots appear; in other words, the efficiency of the condenser can be very materially increased for critical illumination and a larger solid cone obtained by using the flat of the flame as the source of illumination instead of the edge.

FORAMINIFERA.—As notified in the January number, material is now at the disposal of readers of KNOWLEDGE who may wish to practise for themselves the directions given by Mr. Earland in his article on "Foraminifera." There are two kinds—(1) cleaned shore sand from Bognor, Sussex—"washings" or "floatings"—and (2) uncleaned dredged sand from shallow water, Barbados, West Indies. It is requested that applicants for this will enclose a stamped tie-on label addressed to themselves, and state which kind of material they wish for.

NOTES AND QUERIES.

W. A. F.—I have made inquiry with regard to the American Styrax Gum Liquidambar Styraciflua, and find that the liquidambar, which is the medium in which diatoms should be mounted, is almost unprocurable just now, and am told that one well-known diatom-mounter paid 50 francs for a few grammes of this medium. Grubler in his catalogue of re-agents, etc., includes Styrax solution in 10-gramme or 100-gramme tubes at a nominal price.

G. J. Maurice.—The subject of the causation of colorisation of hair is undoubtedly an interesting one, but I am not acquainted with any work which deals with the subject scientifically. You would probably find an opportunity for useful work if you dealt with this subject yourself.

J. F. Hewitt.—I have submitted the specimens and your notes to an expert on these matters, and his reply is as follows:—"My conclusion is that they are *Chloraster tetrarhynchus*, but they alter very much in form during their circle of life. The reproduction is by longitudinal fission, and at this time they develop the eight setase appendages preparatory to fission. I saw the creature on its side, and on the anterior end with the flagella equally separated and seeming to curve upwards. When on its side I saw at the anterior extremity two half-round projections; these were (I think preparatory to fission) the rhynchi or beaks from whence issue the flagella."

Reader of "Knowledge."—In the January number a brief reply was inserted to this correspondent. He has since sent a fair quantity of material found growing in a water supply pipe. This has been examined by correspondents, who have identified it as belonging to the Polyzoa and to be *Paludicella Ehrenbergii*. There are no polypides, they have all died and disappeared, but there are winter buds.

Three other correspondents have sent letters with regard to Paludicella.

One mentions that Prof. Allman's fine Monograph of the British Fresh-water Polyzoa (Ray Society's Publication, 1856-1857) is *the* work to be consulted. Prof. E. Ray Lankester, in the 9th edition of the "Encyclopædia Britannica," examines in some detail *Paludicella Ehrenbergii*, which he takes as a type for comparison with the other groups of the Polyzoan class. The fresh-water groups of the class are also the subject of a Monograph by M. J. Jullien in the *Bull. Soc. Zool. de France*, *Xth.* Further, he points out that "the growths and organisms which establish themselves in the numerous systems of conduits, mains, and other closed channels existing in the kingdom, and used to convey waters of very great variety analytically, derived from sources differing from the superficial to the deeply subterranean, and delivered under a hundred or two of conditions which tend to foster vegetative or animal life, or both, would form a subject for a very extensive Monograph of their own."

The other correspondent gives the following information:—"Paludicella is a fresh-water genus of the class 'Bryozoa' (Polyzoa), sub-class Ectoprocta, order Gymnolaema, sub-order

Ctenostoma. It has a circular disc of tentacles, which are free and of one row only. Johnston's 'British Zoophytes' is the classical work on the 'Hydroida' and 'Molluscoida,' but if the inquirer refers to Vol. 6, p. 420, of the 'Royal Nat. History,' he will find an account of 'Paludicella,' together with a sectional woodcut of an individual animal."

Correspondents who have assisted in this matter have taken a considerable amount of interest in it, and one in particular has expressed a wish to have further material of a similar character sent to him for investigation from time to time.

A. H. Glaister.—There is no special advantage to be derived from the use of a low-power objective instead of an eyepiece, but if you wish to experiment further, you will find that you will do best by inverting the objective used as an eyepiece, so that the light passes through it the reverse way, that is from the back lens to the front lens. The field will then be equal to the angle of the objective. The trouble attributed to the Abbe condenser is in all probability due to the objectives which are visually corrected, and therefore photographically over-corrected. Racking the condenser high up has the same effect as shutting the diaphragm, that is, it utilizes the under-corrected central zone of the objective and thus produces a better photographic effect. A light filter, such as the acetate of copper solution referred to in Knowledge, February, 1901, or a Gifford's Screen, would probably be found advantageous.

Consultants.—An increasing number of correspondents send material and specimens for identification and naming. It would be of great assistance if readers who feel able to do so would co-operate and act as honorary consultants in these matters. I shall be glad to hear from such as are willing to assist, with particulars of the subject they are competent to deal with.

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 1900 II. (Borrelly-Brooks).—In *Ast. Nach.* 3753, Mr. J. M. Poor, of Princeton Observatory, N.Y., asks for unpublished observations of this comet, as he intends to compute a definitive orbit for it. The comet was independently discovered on July 23rd, 1900, by M. Borrelly at Marseilles, and by Mr. Brooks at Geneva, U.S.A., the former having priority by about five hours. The object was fairly bright, with a conspicuous tail about one degree in length, and there were two auxiliary tails or faint off-shoots from the main ray. The comet became very feeble at the end of September, and parabolic elements apparently satisfied the observations.

Encke's Comet.—Though the position of this comet was by no means favourable at his recent return, some excellent observations were obtained at various European stations in the mornings of August and September. In *Ast. Nach.* 3757, Herr H. Struve, of Königsberg, gives the results of measures obtained on thirteen nights between August 8th and September 4th, 1901, inclusive. Sig. A. Abetti, of Arcetri-Firenze, also gives the positions on ten nights between August 9th and 23rd. On August 9th the comet appeared as a faint nebulosity, without a nucleus, and about one minute of arc in diameter.

Fireball of December 4th.—The writer has collected and compared 62 accounts of this brilliant object, but the observations are far from being satisfactory. The real path deduced from them is therefore a little uncertain, so that the exact height of the fireball at its first appearance and final disruption cannot be stated with confidence. But there is no doubt that the approximate elevation was from about 91 to 50 miles over the English Channel, a few miles off the coast of Dorset, and that the direction was from W. to E., with a slight southerly inclination. The streak of the meteor was from 72 to 55 miles high, and 26 miles in length. Several correspondents refer to a hissing or rushing noise which accompanied the flight of the object, while others say that its passage through the air was performed in absolute silence. The great majority of the observers heard nothing, and it is obvious that any detonation proceeding from the disruption of the fireball could not have been heard until several minutes after the phenomenon had disappeared. In describing the fireball of September 14th last, brilliantly visible over South Wales, several of the spectators stated that they distinctly heard a hissing sound simultaneously with the meteor's descent. This is, in fact, a common feature of such observations, but there is no doubt that the impression is an erroneous one. The rushing noise which accompanies the flight of a rocket is familiar to everyone's ears, and amid the surprise occasioned by the sudden apparition of a brilliant rocket-like meteor, the imagination is naturally incited to receive a similar sensation.

Fireball of December 16th.—In the early evening, at 5h. 45m., a brilliant meteor was witnessed by Mr. W. E. Besley at London, by Mr. Johnson at Bridport, and by an observer at Yeovil. At Bridport the object was estimated to be as bright as the moon in her quarters. It moved slowly and vanished near Venus. As seen from Yeovil, the meteor descended in a path parallel with the moon and Venus, and somewhat east of them. The object was probably a late Geminid, moving from N.E. to S.W. over the English Channel, west of Guernsey, and falling from 68 to 54 miles. The length of path was approximately 51 miles, and velocity 20 miles per second, but these results are somewhat uncertain, and it would be useful to hear of further observations.

Fireball of December 19th.—At about 0.45 a.m. on this date a very large meteor was seen in the north of England, but it appears to have been very inadequately observed. Police-Constable Clarke, of Haworth, writes to the *Scarborough Mercury* that he saw a bright light, and on looking up noticed a very large body of some kind travelling along at about the height of an ordinary mill chimney. The object was about as big as the largest ship he had ever seen. It travelled from E. to W., and it went out in the neighbourhood of the seven stars (Pleiades). It was visible for 14 minutes, and left a tail behind it.

THE FACE OF THE SKY FOR FEBRUARY.

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

The Sun.—On the 1st the sun rises at 7.42 a.m., and sets at 4.46 p.m. On the 28th he rises at 6.52 a.m., and sets at 5.35 p.m. The sun appears to be in a very quiescent state, and there is quite a dearth of spots.

Towards the end of the month the Zodiacal Light may be looked for in the west shortly after sunset.

The Moon:—

		Phases.	h. m.
Feb. 8	●	New Moon	1 22 p.m.
„ 15	☽	First quarter	2 57 p.m.
„ 22	○	Full Moon	1 3 p.m.

The more interesting occultations visible at Greenwich are as indicated in the following table:—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Feb. 12	ε Piscium	4·5	7 40 p.m.	124	87	8 18 p.m.	201	162	4 6
„ 14	σ Arietis	5·5	5 53 p.m.	121	110	6 45 p.m.	210	188	6 4
„ 15	B.A.C. 1240	5·7	11 27 p.m.	22	341	11 52 p.m.	333	292	7 10
„ 16	i Tauri	5·1	6 24 p.m.	130	140	7 18 p.m.	222	217	8 5
„ 20	A² Cancri	5·8	6 13 p.m.	116	155	7 16 p.m.	272	307	12 5
„ 20	60 Cancri	5·7	11 16 p.m.	70	64	0 11 a.m.	334	315	12 10

The Planets.—Mercury is an evening star, and has an easterly elongation of 18° 17′ on the 3rd. About this time the planet will be favourably situated for observation, as he remains about 1h. 45m. above the horizon, after the sun has set. The path of the planet lies in Aquarius and makes a loop around the fourth magnitude star θ Aquarii. On the 2nd of the month it has the same R.A. as the star, but is $2\frac{1}{2}$° to the south, its motion being easterly, and on the 16th it again has the same right ascension as the star, but is 1° to the north, its motion being westerly, bringing it into inferior conjunction with the sun on the 18th.

Venus, also in Aquarius, is an evening star for a few days in the earlier part of the month, but its rapid retrograde motion brings it into inferior conjunction with the sun on the 14th. On the 1st of the month it sets about

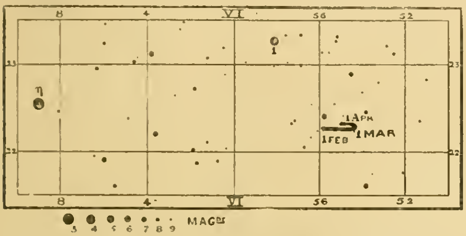
7 p.m., or more than two hours after the sun; about this time the planet presents a large crescent of nearly 1′ diameter to a telescopic view.

Mars is also in Aquarius, but sets shortly after the sun, and is therefore not suitable for observation.

Jupiter and Saturn are in Sagittarius, but as they rise only about an hour before the sun, they are inconvenient for observing purposes.

Uranus is in the most southerly part of Ophiuchus near the stars θ and ξ Ophiuchi, and rises a little more than three hours before the sun; its great southerly declination, however, makes it somewhat unsuitable for observation.

Neptune is favourably situated throughout the month. He crosses the meridian at 9.11 p.m. on the 1st, and at 7.23 p.m. on the 28th. The planet is still on the borders of Gemini and Taurus, not very distant from 1 Geminorum. The accompanying chart should enable it to be



Path of Neptune from 1st February to 1st April, 1902.

found readily. The chart shows all the stars down to the 8.5 magnitude, which lay near the planet's track. The planet appears in the telescope as a star a little brighter than the 8th magnitude, the colour is said to be greenish, but this is not very noticeable in small telescopes.

The Stars.—The positions of the principal constellations about 9 p.m. at the middle of the month are as follow:—

Zenith . Auriga (brightest star *Capella*), is a little west of the zenith.

South . Gemini *Castor* and *Pollux*) high up, *Procyon* and *Sirius*; Orion is a little west of the meridian, Taurus is to south-west, high up, Cancer and Hydra to the south-east.

East . Leo (*Regulus*) a little south of east, Virgo low down, to the north-east Ursa Major, *Arcturus* rising.

West . Perseus, Pleiades, Pisces and Aries with Cygnus to the north-west, and Cetus to the south-west.

North . Cassiopeia, Cepheus, Draco and Ursa Minor, with *Vega* on the horizon.

Minima of Algol occur at convenient times on the 17th at 11.43 p.m., and on the 20th at 8.32 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.

No. 1.

(S. G. Luckcock.)

1. Kt × P, and mates next move.

No. 2.

(C. D. Locock and J. K. Macmeikan.)

Main Solution.

Key-move.—1. B to B4.

If 1. . . . P to R7, 2. R × QKtP, etc.
1. . . . P × B, 2. R to QB5, etc.
1. . . . P to K4, 2. R to KB5, etc.

[A second solution by 1. R to K5 was intentionally left, partly because it could hardly be avoided, while a third by 1. R to Kt4, was left accidentally, the authors erroneously supposing that 1. . . P to K4 would be a valid defence. The main idea of the problem, in fact the primary object in view, was the "try" by 1. Kt to Kt6, P to R7; 2. Kt × P at Q2 (or Kt to QB4), P to R8 (becoming a Bishop); 3 Kt to K5, stalemate. We print below, in case it may be of interest, an earlier, and in some respects superior version of the problem, which the authors believe to be sound, though it was rejected as not being so suitable to the special purpose in view as the unsound version given last month.]

Mr. W. Nash was credited with a point too few last month. He should accordingly have been bracketed ninth, with a score of 64.

Correct Solutions of No. 1 received from J. Baddeley, Alpha, W. Nash, W. de P. Crousaz, W. V. M. Popham, G. W. Middleton, W. Jay, G. Woodcock, H. Le Jeune, F. Dennis, W. H. Boyes, C. Johnston, C. R. Beechey, E. F. B. Barlow, H. H. S. (Teddington), A. C. Challenger.

Of No. 2 from W. Jay (2 solutions), Alpha, S. G. Luckcock, W. Nash (2 solutions), W. de P Crousaz (3 correct, 1 incorrect), W. V. M. Popham, G. W. Middleton (1 correct, 1 incorrect), W. H. Boyes, C. Johnston (3 correct, 1 incorrect), C. R. Beechey (1 correct, 1 incorrect), H. H. S. (Teddington), A. C. Challenger, four of whom, besides seven others, have duly fallen into the "stalemate trap." Mr. Luckcock alone has commented on the trap, though of course others may have seen through it.

Several correspondents.—Many thanks for your good wishes.

Balham.—[I cannot find your signature.] In No. 1, R to Bsq. is answered by Kt × R or Kt to B3. In No. 2, after 1. B × RP, P to R7; 2. R × QKtP, P Queens; 3. R to QKt8, Q to B6 (or 8), there is no mate. The Bishop must go to B4, in order to nullify the effect of Black's third move.

C. R. Beechey.—Your claim for duals in No. 1, after three moves of the Black Knight, is quite correct.

G. Woodcock.—After 1. R to KKt2, P to R7; 2. R (Ktsq) × P, P Queens, 3. R to Kt8, Black replies Q to B6 (or 8).

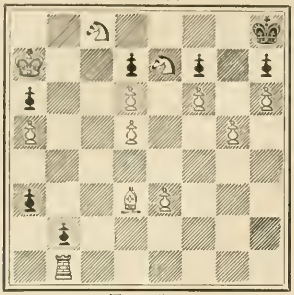
G. W. Middleton.—Have written to the publishers accordingly. Congratulations on your other success.

W. Nash.—I regret the mistake, which I had suspected, but was unable to verify. The fact that I had destroyed your card made me suspect that I had credited you with a point too little, as it is my practice to destroy only those solutions which score full points.

E. F. B. Barlow.—Thanks for the problem, which shall appear shortly if found apparently sound. Could you not find a less *strong* key? Your particular method of printing is new to me, though rubber stamps are of course constantly used for printing the pieces.

A. C. Challenger.—Have noted your preference as to date.

REPRINTED PROBLEM.
By C. D. Locock and J. K. Macmeikan.
BLACK (7).

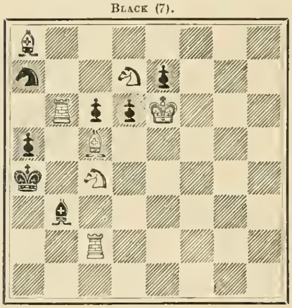


WHITE (12).
White mates in three moves.

Solution.

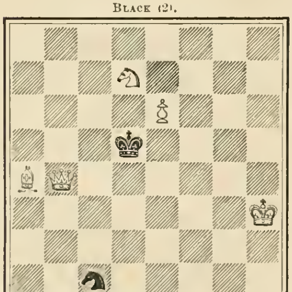
1. B to B4, P to R7.
2. R × P, P Queens.
3. R to Kt8. Q moves.
4. Kt to Kt6 mate.

PROBLEMS.
By P. H. Williams.
No. 1.
BLACK (7).



WHITE (7).
White mates in two moves.

No. 2.
BLACK (2).



WHITE (5)
White mates in three moves.

CONCLUSION OF SOLUTION TOURNEY.

The tie for first and second prizes between Messrs. Jay and Johnston has been decided by means of the four-move problem in the January number, and a special three-move problem (with two solutions) sent to them by post. The result was that Mr. Johnston sent both keys (B to Ksq and B to R3) to the three-mover, and three correct keys (besides Kt to Kt6, incorrect) to the four-mover, scoring therefore $15-2=13$ points. Mr. Jay sent only B to R3 (the cook) for the three-mover, and two keys (B to B4 and R to K5) for the four-mover, scoring 9 points. After an exceedingly close struggle, Mr. Johnston accordingly wins the first prize of one guinea, Mr. Jay obtaining the second prize, consisting of twelve months' subscription to KNOWLEDGE. The award, as usual, remains open for one month.

Owing to want of space, and the fact that details of the Challenge Trophy have not yet reached me, the publication of conditions of the next Solution Tourney is postponed till next month.

CHESS INTELLIGENCE.

British Chess Magazine.—Three-move Problem Tourney. Competitors are reminded that entries for this event, for which valuable prizes have been presented by Sir J. O. S. Thursby, close, for European competitors, on January 31st. Entries, with motto, sealed name and address, etc., should be sent to the Problem Editor, 21, Nelson Road, Stroud Green, London, N. Dr. C. Planck and Mr. C. D. Locock have been appointed judges.

The New Century Chess-Book (Sampson Low, Marston & Co.) is the title of Mr. James Mortimer's supplementary continuation of his well-known *Chess Player's Pocket Book.* Its contents comprise all the most modern lines of play in the various openings, special prominence being given to the Rice Gambit, which has the distinction of being the only opening in which a piece may be sacrificed early without obtaining a demonstrably lost game. The price of the book is 1s., and there is no reason why it should not become as popular as its predecessor.

The "Elsie" Chess-Board and Men (British Chess Company, Stroud, Gloucester) is made in three sizes, 8×6, $9\frac{1}{2} \times 7$, and $10\frac{1}{4} \times 7\frac{3}{4}$ inches, the prices being respectively 4s., 4s. 6d. and 5s. The board is of stout varnished millboard, fixed into a covered cardboard box, with holes for the pegged men, whether in play or captured. The chess men are of wood and of a good pattern. Altogether, this is certainly the simplest and quite one of the best of *in statu quo* boards.

The latest edition of Mr. Rhodes Marriott's *Chess-Players' Note-Book* (Sherratt & Hughes, Manchester) is certainly very cheap at 1s. It contains 165 pages, bound in cloth, every page being perforated for detachment. Part I. consists of 20 diagrams, the reverse sides being used for recording games or solutions. The bulk of the remainder consists of game-recorders, with letter-forms to Chess-Editors, a summary of the results of games, and space for newspaper cuttings. Mr. Edwyn Anthony's *Notes on the Opposition* are also included.

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

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CONTENTS.

STUDIES IN THE BRITISH FLORA.

By R. Lloyd Praeger, B.A.

II.—NOTES ON PLANT GEOGRAPHY.

It is a matter of every-day observation that the flora of two adjoining districts is never in all respects identical. Even if we carefully list the plants growing in one meadow, and compare it with the flora of an adjoining one, which, in respect of size, situation, soil and moisture appears precisely similarly situated, a certain diversity will be found. This arises from the fact that plants are so nicely adjusted to particular conditions of light, temperature, moisture and soil, that differences of these, almost inappreciable to our observation, will produce a slight balance in favour of one species as compared with another. In our meadow the ground is already densely overcrowded with plants, all of which have through long competition with their neighbours seized on every device and habit that will aid them in the struggle, and have established by force of arms their right to live. They all grow, so to speak, under high pressure, and the least change of outward conditions which tells in favour of one species is taken advantage of, and the less adapted plant goes under. So we can understand that any area of natural vegetation displays a complicated adjustment as regards its composition, and that the distribution of the component species is the inevitable result of a complex set of conditions, not the effect of chance.

In limited areas, moisture is the dominant factor of environment which determines the nature of the flora. If one meadow is marshy and another dry, a greater change of flora is produced by this variation than would result from any other physical difference. Soil is probably the next most important factor. When we come to deal with larger areas, climate begins to assume importance, till at length, in surveying the vegetation of the globe, we find climate the grand dominating influence which gives to countries and to continents their floral characteristics.

Of the four great Zones of Heat—Torrid or Intertropical, Warm-temperate, Cool-temperate, and Arctic-Alpine or Frigid—into which the earth's surface has been divided, our Islands lie in the Cool-temperate, with certain mountain-tops rising into the Arctic-Alpine. The general floral characteristics of this zone are the number of deciduous trees in proportion to evergreens, the number of herbaceous plants in proportion to trees, the gregarious or social character of many of the trees and shrubs, such as Pine, Oak, Gorse, Heather, which form vast colonies; and the abundance of greensward-producing grasses, and of terrestrial mosses and foliaceous lichens. Compared with the Tropics, we see in the increase of herbaceous plants and of deciduous trees, and of hardy low-growing plants of all kinds, adaptation for the successful weathering of our winter, a climatic change unknown in the Tropics. As compared with the vegetation of the Arctic-Alpine zone, the Cool-temperate zone is remarkable for its forest-trees, which are unsuited for the long, cold, stormy winters of high latitudes, and for its abundant annual plants, which under arctic conditions would not find, during the brief summer, a warm period sufficient for their growth, flowering and ripening of seed.

To the character of our climate and vegetation we owe one of the most delightful features of these countries. On account of the cessation of vegetative growth during our winter, the plants, unlike those of the Tropics, have to compress their period of flowering into a few summer months; and it is this, coupled with the gregarious or social character of the flora, that gives us our lovely English fields of Buttercups and Daisies, our glorious sheets of Golden Gorse and Purple Heather, which we would in vain attempt to match amid the heavy luxuriance of tropical vegetation.

While our British flora is thus relegated *in toto* to one of the great climatic floral divisions of the world, it is yet by no means homogeneous in character. Great Britain extends over some 700 miles north and south, a range of latitude sufficient to produce a considerable contrast between the flora of its opposite limits. A difference in annual temperature of over five degrees Fahrenheit exists between Caithness and Cornwall. But the actual conditions of temperature under which the British flora exists is far more varied than this. The requirements of a plant, as regards temperature, includes two important factors. It must have heat enough during summer to mature its seed, and the winter temperature must not be so low as to injure its tissues. The natural limits of a plant's range are usually fixed by one or other of these conditions, according as the constitution of the plant renders the question of summer maximum or winter minimum temperature the more important to it. The presence of large land areas conduces to a wide range of annual temperature—hot summers and cold winters—and in continental areas, therefore, the former class—heat-lovers, or *thermophiles*—find a suitable abode. An insular area, on the other hand, affected by the comparatively constant temperature of the surrounding ocean, exhibits a more equable climate, and here the second class—cold-fearers, or *frigofuges*—will congregate. While, in comparison with most parts of the European continent, the British

"Oh! to be in England
Now that April's there"

A typical Cool-temperate plant association—sward-forming grasses and low herbaceous plants, with groups of deciduous trees.

Isles possess an insular climate and a frigofuge flora, we may trace within our area considerable variation in this respect. Thus, the east of England, when compared with west, or much more with the west of Scotland or Ireland, has a continental climate. The annual range of temperature in the eastern counties of England is nearly double of that which obtains on the west coast of Ireland or the Outer Hebrides. And another question is bound up with this one. An insular climate is characterised by a moist atmosphere, the result of proximity to the sea; the continental climate by a drier atmosphere. Plants exhibit marked preferences in respect of aerial moisture, some favouring the dampness of an insular climate (hygrophiles), some the dryness of a continental (xerophiles). In the British Isles the thermophiles and xerophiles reside largely in the dry sunny eastern counties of England, while the frigofuge and hygrophilous species increase westward. These two groups, in fact, constitute in great measure H. C. Watson's "Germanic" and "Atlantic" types of distribution, the one characterised by its increase in the east, the other in the west of England. As we go northwards, likewise, into the colder and wetter regions of Scotland, the East-England group dies out, and is, in the extreme north and on the hills, at length replaced by various species of the Arctic-Alpine flora, which are essentially hygrophilous, though not frigofuge. These beautiful little northern and alpine plants are accustomed to a damp air, little sunlight, and a soil wet yet thoroughly drained—facts to be remembered in our attempts to grow them in our gardens.

But there are many species sufficiently plastic in their constitution to accommodate themselves to every variety of climate to be found in Britain. These widely distributed species constitute the "British type" of H. C. Watson. Some of them even range from the summit of the highest mountain of northern Scotland to sea level in the south of England. Most of them are characteristic members of the Cool-temperate flora.

When we come to consider the flora in greater detail, wide diversities of vegetation become at once apparent, and these, as already stated, are due largely to differences of moisture and soil. On a great turf-bog, for instance, where the supply of water is equal, and the soil everywhere the same, an almost absolute uniformity of flora exists, sometimes over thousands of acres. But usually our country exhibits considerable diversity of flora even within limited areas—the plant-associations characteristic of meadow, wood, marsh, stream, and gravelly or sandy wastes, compared with which agreeable variety the uniform, though often rich and beautiful flora of the veldt, prairie, savannah or steppe were monotonous. The effect of this diversity of conditions is that, from the point of view of any one of the constituent plant-groups, the country consists of a sprinkling or network of oases set in a desert—an archipelago, in fact. The major portion of the surface of our Islands consists of dry ground capable of producing crops of the plants useful to man, and has, as a matter of fact, been tilled for many hundred years. To the effect of tillage in destroying the natural plant-associations, reference was made in a previous article, where also the converse result of man's operations in introducing alien plants was enlarged upon (pp. 16-19 *supra*). But the bulk of the native plants of ordinary soils—*mesophytes* as they are called, from their requiring a moderate supply of water—still hold the ground in lessened numbers, and are widely spread, since the area suitable for their growth stretches continuously, forming, indeed, the sea in which the islands of very wet soils or very dry, of very limy soils or soils devoid of lime, are set. The Daisy, Bramble, Honeysuckle, and Ribwort Plantain, for instance, spread continuously over the surface of our country, and easily avoid the only barriers—the higher mountain-chains—which might impede their progress, by out-flanking them. It is different, however, in the case of hydrophytes and xerophytes—water plants and desert plants. Take the case of one of the common Pondweeds—say *Potamogeton lucens* or *rufescens*. These plants grow *in* water, and need this medium continually round them; their flowers alone rise above the surface, in order that the good offices of the wind may be utilized for effecting cross-fertilization. Lakes are their favourite habitat, they dislike flowing water, and more still rapid alterations of level, so that we seldom see them in rivers, or in dams or reservoirs. How are plants such as these to spread? The question may well give us pause. Their seeds* are too large and heavy to be borne by the wind, even if they ripened above the water, which they do not; and if entrusted to the stream which presumably drains

* I use the word "seed" in its popular sense—"a one-seeded unit of dispersal."

the lake, it is a question whether they would reach any other lake. The Bur-reed, so common in ponds and ditches, requires less deep and open water than the Pondweeds just mentioned; it is one of the plants of the fringe that separates the aerial from the subaquatic flora. Its seeds are likewise comparatively heavy, and not possessed of any special means of dispersal, yet it is a more widely-distributed plant than its companion the Reed-mace, which is furnished with innumerable light parachute-fruits, which it disperses annually over the country in tens of thousands, by the aid of the wind. The Yellow Iris has very heavy seeds, which cannot easily attain wide dispersal except by running water. But as a damp meadow provides a sufficiently wet substratum for the plant's growth, it has a wider range than species which need standing water. Its terrestrial habitat, too, brings it into contact with the larger animals, which in many ways help to scatter seed of all sorts. As to the water-plants before mentioned, aquatic birds perhaps assist dispersal more than any other agency. A great variety of seeds is mixed with the mud on the banks and in the beds of rivers and lakes, and many have been observed adhering with mud to the feet of wading birds. Other seeds have hard coats, which allow them to pass without injury through the alimentary canal of birds—digestion in birds being extremely rapid. That the seeds of the marsh and water plants *do* succeed in crossing the "deserts" of dry soil that hem them in on every hand is sufficiently evident; not a lake or pond but has its subaquatic association of Pondweeds, Water-Starworts, Water-Milfoils, Stoneworts, and so on, and its marginal fringe of Bur-reeds, Bulrushes, Reed-maces, and aquatic sedges and grasses. The "islands" of the opposite kind—very dry spots—have a more local development. They consist of sandy and gravelly wastes, and of rocks. As pointed out in a previous article, some of the rock plants have taken advantage of the wall-building proclivities of mankind to widely extend their domain; and mention has been also made of the fact that certain other xerophytes have followed the narrow strip of tenable ground supplied by the ballasting of railways right across an inhospitable clay-covered country. While the lighter soils and drier climate of the south and east of England permit of the growth of many such plants, their numbers decrease in the more rainy districts, and in Scotland and Ireland we find the xerophytes aggregated on the sands of the sea-coast.

When we come to examine the distribution of individual species, we find that while as regards *habitat* they consistently seek a due amount of water and a suitable soil and situation, yet their distribution is full of anomalies. What I mean is that while the occurrence of a certain plant points to the presence of certain conditions, the presence of certain conditions does not by any means necessarily involve the occurrence of the plant. This is where the historical element comes in. The flora as we find it now is the result of a long and eventful past. Species have arrived and departed, have advanced and retreated, in obedience to overmastering changes in climate and in the distribution of sea and land. That the bulk of our present flora migrated hither over a continuous land-surface at the close of the Glacial Epoch, from those southern parts of Europe which, though much colder than at present, were then free from ice, and able to support a Cool-temperate flora, we may safely assume. In colonising the country, the more plastic species spread over the land from end to end. The hardier plants followed the retreating ice northwards, and found a congenial home in Scotland, and northern England and Ireland. The sun-loving plants—perhaps for this very reason the latest comers—settled down in the warm and dry eastern counties of England. The remnants of the pre-existing flora, composed largely of Arctic-Alpine plants, retired in great part to the mountains. Some strange conditions appear to have existed along the old western sea-board, which allowed traces of the ancient pre-Glacial flora of southern plants to survive in Ireland and the south-west of England.

But even when the heterogeneous elements of the vegetation had settled down in accordance with the prevailing conditions, there was no pause in the ever-changing order of things.

> "Turn, turn, my wheel; all things must change
> To something new, to something strange,
> Nothing that is can pause or stay."

Some plants extended their domain; others sank in the grim struggle for existence. The older forms, presumably less suited to the new conditions, may well have found life difficult. Now, when a plant is increasing its area, or is at the high-water mark of its prosperity, we may expect to find its range continuous over the area which is suitable to its growth, like a pool of water which is enlarging. But if a plant's dominion is on the wane, and its area shrinking, it will retreat irregularly, clinging to its favourite habitats long after it has been swept away from the adjoining areas; its distribution will become discontinuous, like that of a pool of water which is drying up, and leaves for a while isolated wet patches in the spots best able to retain water. Thus it is that our arctic plants have shrunk back to the mountain-tops, where they now exist often in a perfectly isolated condition, and cut off from all communication with their former companions, imprisoned on other peaks. To quote equally conspicuous instances of *increasing* species is not easy, as the only plants of the kind which one can *see* increasing are weeds introduced by man, and consequently not subject to natural conditions; but a glance at the map in the January number of Knowledge, in which I illustrated the recent spread of three introduced railway colonists, will show that even each of these has a continuous range, and the appearance of having originated from a single centre of dispersal. Let us look more closely into some of these cases of discontinuous distribution. The most conspicuous instances belong to plants of distinctly northern or southern type. A number of species of the Arctic-Alpine group, left stranded on our mountain-tops as the cold of the Glacial Epoch retreated, are now represented by solitary plant-islets amid the sea of more southern forms, for instance: *Arabis alpina* (one spot in Skye); *Arenaria ciliata* (King's Mountain, co. Sligo); *A. uliginosa* (by one rill in Teesdale); *Saxifraga cernua* (Ben Lawers); *Mulgedium alpinum* (Forfar and Aberdeen); *Phyllodoce cærulea* (Sow of Athol); *Gentiana nivalis* (Breadalbane and Clova); *Pinguicula alpina* (Skye and Ross). These are all plants of the high north, or of the alpine portions of Europe.

The southern plants which form islands are often less rigidly restricted in their range, since they are low-level dwellers, and have better opportunity of spreading horizontally. *Euphorbia hiberna* and *Saxifraga umbrosa*, for instance, have a wide range along the western and southern coasts of Ireland, the latter showing its flexibility by ascending the mountains into the haunt of the alpines. *Pinguicula grandiflora* grows in profusion over great part of Cork and Kerry, an area of several thousand square miles, ascending like the last to a considerable elevation. All of these are southern forms. The most striking instances of these plant-islands, however, are those formed by species which have a wide range over the European continent, and might, therefore, be expected to find, so far as the all-important factor of climate is concerned, a suitable home in many parts of our islands. Yet remarkable cases of discontinuous distribution are not wanting. *Inula salicina*, for instance, is scattered over the shores and islands of Lough Derg in Ireland. Though widely spread in Europe and Asia, it is absent elsewhere in the British Islands, and furnishes a very remarkable example of an outlier of the kind referred to. *Carex Davalliana*, widely spread in Europe, had its only British station at Bath, but is now extinct there. *Carex Buxbaumii* should perhaps be reckoned with the relics of the Glacial flora; with a vast range abroad—Arctic and Alpine Europe, Asia, America, and Australia—it is represented in our islands by two patches, one in Scotland (Argyll), one in Ireland (Lough Neagh). Other examples of outlying stations of species widespread in Europe are afforded by *Dianthus cæsius* (Cheddar), *Selinum carvifolia* (Lincoln and Cambridge), *Peucedanum officinale* (Kent and Essex), *Cnicus tuberosus* (Wilts), *Phyteuma spicata* (Sussex), *Teucrium Botrys* (Surrey), *Herniaria ciliata* (Hants), *Epipogum aphyllum* (Hereford). In some of these instances, where the British habitats adjoin the Channel or the North Sea, they may perhaps be looked on as lying on the natural margin or climatic limit of the species; but in other cases the isolation of the stations appears to point to a shrinkage in the former area of distribution, and a distinct "island" formation.

It should be pointed out, however, that a plant-island may mean the very reverse of what has been exemplified above. A recent immigrant which has secured a hold in our country is bound, in the earlier stages of its history, to show a range resembling in its isolation that which has been described as characterizing the older members of the flora. To take an instance. The prickly North American knot-grass, *Polygonum sagittifolium*, has formed a flourishing colony in wild ground in Kerry. The North American orchid *Spiranthes Romanzoffiana*, which till quite recently was in Europe known only in this single station, has a similar colony in the adjoining county of Cork. Both are unknown in Great Britain and elsewhere in Europe. While the latter is regarded by botanists as an extremely ancient native, the former is looked on as probably a recent immigrant. The case of this *Polygonum* is a particularly difficult one. Usually, the plants introduced through man's agency show a decided aggregation about man's works—towns and harbours and cultivated land; while the old inhabitants, compared with whom the human tiller of the soil is a late comer, shrink from contact with man, and rejoice in thoroughly wild ground.

THE MIGRATIONS OF THE SKYLARK AND THE SWALLOW.

By Harry F. Witherby, F.Z.S., M.B.O.U.

In Knowledge for January, 1901, I called attention to Mr. W. Eagle Clarke's summary of the migrations of the song thrush and white wagtail. The Report of the Migration Committee of the British Association, for 1901, contains summaries, by Mr. Clarke, of the migrational movements in the British Islands of the skylark and the swallow. The facts cleverly elicited and summed up by Mr. Clarke are so important and valuable that they should be widely known, and I have attempted below to extract the essence from Mr. Clarke's summaries. The summaries themselves, however, are so condensed in form that every word in them is valuable, and the complete paper should be read by those particularly interested in the subject. The committee announce that they are hopeful, in the course of two years more, of giving summaries of the movements of all the most representative species of migrants. It is difficult to realize the labour involved in unravelling from the mass of facts, collected by means of the schedules supplied to the lighthouse keepers, a coherent and orderly account of the migrations of any single species. But Mr. Clarke, on whom has fallen the entire burden of this work, by long labour and well-considered methods has been most successful, and is much to be congratulated on having traced and set forth very clearly and succinctly the intricate migrations of birds as observed in the British Islands.

THE SKYLARK.

The skylark is so common in England all the year round, that few people would suspect it of being a great wanderer. Yet as a migrant, no species makes so great a show in the returns of the light stations, and the complexity of its movements surpasses that of any other British bird. Mr. Clarke has separated these various movements as follows:—

In autumn—

(1) Certain skylarks which have nested here leave for the south.
(2) Others come from Central Europe to winter here.
(3) Others again arrive from Northern Europe to winter in our country.
(4) Others pass along our coasts on their way from Central Europe to Southern Europe.
(5) While others use our coasts as a highway on their journey from Northern to Southern Europe.

In the spring all these movements are reversed.

In winter, if there is severe weather, many birds leave us, and a number of more or less local movements take place.

To deal first with the home-bred birds. Although a great many of the skylarks which breed in the British Islands undoubtedly live with us all the year round, great numbers of them are strictly migratory. The emigration* of British-bred birds commences almost as soon as the nesting season is over, when skylarks begin to depart from the Hebrides. The migration continues to gain in strength as the autumn advances, and by September and October the skylarks which nested in Scotland and in many parts of Ireland, and the north of England, journey to the coasts in small bands, and make their way leisurely southward, to winter some in the southern and western counties of England, others on the Continent. During March and April these home-bred birds return.

Though a considerable number of skylarks thus leave us in autumn, their departure does not materially affect the abundance of the species, since prodigious numbers, from Central and Northern Europe, come to winter here. Indeed, so vast are these numbers, that in November, when most of the migration has ceased, our skylark population is undoubtedly at its maximum. It must be remembered, however, that at this time cold and want of food has not decimated them, and the skylark being regularly double-brooded, and often rearing even three broods in a season, increases in numbers in a marked degree in autumn from this cause.

The immigration of skylarks to the British Islands from Central Europe in the autumn is one of the most remarkable movements connected with the migrations of this bird or, perhaps, of any other British bird. It has been laid down as a principle of migration, that birds invariably move southward in autumn and northward in winter, but

* The terms "emigration" and "immigration" here used refer to the migration from and to the British Islands.

in this migration of the skylark from Central Europe, the birds proceed westward and possibly northward from their breeding grounds to reach their winter quarters. This immigration begins usually at the end of September, reaches enormous proportions in October, and practically ceases at the beginning of November. The birds strike our east coast in extended formation, reaching from the Humber, and even the Tees, to the south coast. Some idea of the magnitude of this influx may be gathered from the fact that in four years out of the eight covered by the enquiry, skylarks were observed to arrive by this route on over twenty days in each October.

An interesting fact in connection with the immigration from Central Europe is, that the passage across the North Sea is invariably performed in the day-time, the birds arriving from dawn until noon. Mr. Clarke does not make it quite clear whether the whole journey is sometimes performed in daylight or not, but since all important migrations are begun in the evening it seems that these birds have been travelling all night. Sometimes, however, they do not arrive before 3 p.m., and then the very remarkable, but not very uncommon, spectacle may be witnessed of two streams of birds of the same species migrating in opposite directions. For at this time in the afternoon our home-bred skylarks are starting on their journey to their winter quarters on the Continent, and their line of flight is actually crossed by the skylarks coming from Central Europe.

The coast, however, is not the ultimate destination of these travellers. On their arrival they disperse in various directions. Many intend to spend the winter somewhere in our islands, and of these some go inland and scatter over the eastern, southern and midland counties of England, but the majority proceed southward along the east coast and then westward along the south coast. Arrived at Land's End, many continue on a westerly and northerly course and so reach Ireland. Large numbers of these skylarks, however are merely birds of passage with us, and on arriving in the west of England, they cross the channel at various points to the French coast.

The return of these birds to their breeding haunts in Central Europe in the spring comes very little under observation compared with the inflowing streams in autumn. The reasons for the want of observation are easily explained To begin with, the number of skylarks has been enormously lessened by the ravages of winter as well as by the dangers of the long journeys. Then the birds set out from the coast in the evening, and on starting rise to such a height that they are seldom attracted by the lanterns of the lighthouses as they are when descending as they near the coast. But enough observations have been recorded to show that the return is made on much the same lines as the arrival, and that the movement begins in February and is continued until the end of March, the 28th being the latest day recorded.

There is yet another perfectly distinct migration of the skylark to be observed in Great Britain. This movement is concerned with the birds which summer in Scandinavia and seek our shores in autumn. The vanguard of these northern skylarks arrives very punctually in the first week in October, and the whole migration is usually compressed into four weeks, so that, as a rule, it ceases early in November. By this route, again, enormous numbers of skylarks reach our shores, but they strike the coast further north than those from Central Europe. Some pass down the coast, and leave us for warmer climes, but the majority disperse themselves over our islands, some reaching the Hebrides and replacing the home-bred birds which have already left their summer haunts. In mild seasons, during the third week in February, the birds begin to return to the north by the routes taken in autumn, and throughout March, especially after the middle of the month, there is much evidence of their departure.

The above-mentioned movements of the skylark (viz.: Emigration of home-bred birds; immigration of winter visitors and birds of passage from Central Europe; immigration of winter visitors and birds of passage from Northern Europe; and the return journeys) are those of a strictly migratory character which have been observed in the British Islands; but reference must be made to other movements, which depend entirely on the state of the weather. The skylark obtains the whole of its food on the ground, and hence a fall of snow or a prolonged frost drives it to change its quarters. Should the cold be of short duration, the movements of the skylarks are merely local, and the birds soon return to their former haunts. Should, however, the adverse conditions continue and become general, the movement becomes widespread and almost universal. "This effect," says Mr. Clarke, "is especially produced by great snowstorms, when the number of fugitives is so vast that people wonder where such prodigious multitudes can come from, as they throng towards the coast, and particularly the milder south-west coast of England . . . . though many undoubtedly cross the Channel and others proceed to Ireland."

THE SWALLOW.

The familiar Swallow may be taken as a typical example of a summer resident in the British Isles. Although its migrational movements in this country are much more simple and more easily followed than those of the skylark, it must be borne in mind that the birds which migrate to and from our shores are not all summer residents. Some of them are merely birds of passage passing through on the way to their breeding stations in Northern Europe. The winter quarters of the swallow are known to be in Africa, chiefly to the south of the Great Desert.

In dealing first with the spring immigration of swallows, which come to breed in this country, it should be stated that Mr. Clarke's material is so complete that he is able "to speak with authority as to the date of the swallow's successive arrivals on our shores, and also to trace with some degree of accuracy its gradual spreading over the country, which has hitherto been a *desideratum*."

A few solitary birds annually appear in March, but it is not until April that the vanguard of the host arrives. These early arrivals are either single birds or pairs. About ten days after the first comers, swallows appear in some numbers, and the influx proceeds throughout the rest of April and the first half of May. Those which arrive later are birds of passage proceeding to higher latitudes.

The first arrivals appear at different dates in different parts of our islands, and the appearance of swallows on the western seaboard, not only of the South of England but also of Scotland, is always some days in advance of their arrival on the east coast. Mr. Clarke has drawn up the following table of first arrivals: For south-western England, the beginning of the first week of April; for Ireland the end of that week; for south-eastern England, early in the second week; for south-western Scotland, the end of the same; for south-eastern Scotland, the middle of the third week; for northern Scotland, the fourth week; and lastly, it is not till the second week in May that the few swallows which resort to Orkney reach their destination.

As regards the manner in which the migration is performed, Mr. Clarke writes:—"Swallows are described as arriving on our southern shores during the day-time, chiefly in pairs, but sometimes as many as six or seven together, and flying low over the sea. The immigration lasts most of the day; but they are also noted as coming in small parties, flock after flock, for several hours in succession, and unaccompanied by any other kind of birds."

In the last week of August there is a decided southward movement of the swallows in Scotland and the North of England, while in Ireland there is a movement to the coast in August. There is no evidence that these birds actually quit the country, and they probably wait some time in the southern counties before crossing the Channel. In September the southern movement becomes general throughout the country, and in the early days of that month the swallows begin to cross the Channel. The emigration reaches its maximum near the end of September, and by the middle of October it is practically over as far as Scotland and the north of England are concerned. But the swallows continue to leave the south of England until the middle of November, while stragglers are often seen later, especially in the south-west. A December swallow, however, is a very rare occurrence.

The swallows depart in much the same way as they come, except that they are, of course, more numerous, and they leave in perhaps larger bands. As far as it has been observed, the "emigration usually takes the form of the continuous passage of small parties, not exceeding a score, and as this may last for hours, vast numbers thus depart." Swallows have, however, been observed "on the south coast to assemble in thousands and fly away *en masse*, but this is only occasionally recorded." It seems that in some cases old and young birds migrate separately, and in others that they are proportionately mixed. The time of day at which they migrate is also varied. Swallows cross the English Channel by many routes, although there are certain much-used points of departure.

Little need be said about the swallows which visit us on their passages to and fro from the countries to the north and south of us. In the spring this migration sets in at the end of April, reaches its maximum about the middle of May, and may be prolonged until nearly the middle of June. Many of the earlier of these migrants reach our coasts in company with our own swallows. The migration is almost entirely confined to the east coast, and the North Sea is crossed before the northern limit of the mainland is reached. A few swallows may reach Northern Europe from the west of Scotland. After spending the summer in Scandinavia these swallows begin to return with their young along our east coasts on their way to Africa, in the middle of September. The passage is well maintained during the rest of the month, and is prolonged by a few birds to the first or second week in October. On their arrival on our shores these birds mix with our own swallows, and trace is lost of them, but it is more than likely that our milder climate induces many of them to linger, and if this is really the case, the lateness of migration on the east coast, as compared to that on the west coast, would be accounted for.

It will be seen from the foregoing brief summary, that Mr. Clarke has now put us into possession of a very complete history of the migrations of the skylark and the swallow, as observed in the British Islands. Beyond their intrinsic value and their great interest, such clear statements of facts will go far to solve the many important problems connected with the migrations of birds.

LIKE AND YET UNLIKE: THE FLYING-SQUIRRELS OF ASIA AND AFRICA.

By R. LYDEKKER.

DESPITE the repetition of the statement as to their essential structural difference in almost every work on popular natural history issued to the public, few persons, save those who have made anatomy a special study, can be induced to believe that swallows and swifts are not closely allied birds. And it may be presumed that an equal degree of incredulity will prevail in the minds of most people when they are told that the two animals whose portraits are given in the plate accompanying this article have no sort of intimate relationship, being in fact much more widely sundered from one another than are such apparently dissimilar creatures as a squirrel and a beaver An instance of this incredulity has indeed been actually published with regard to the animal shown on the right side of the plate, which is one of the so-called African flying-squirrels, or, as they might be better termed, scale-tailed squirrels. Now this particular species of the group was sent home from Central Africa by Emin Pasha in the eighties, and described and figured under the name of *Anomalurus pusillus* by Mr. Thomas, of the British Museum, in 1887 and 1888. Three years later his figure (the one here reproduced) appeared in Major Casati's "Ten Years in Equatoria," with the following remarks:—

"The flying squirrel (*Mboma*) lives in the forests, almost always upon the branches of the trees, whence it throws itself, expanding the membrane which joins the feet to the body, like a parachute. The skin is used as an ornament. I think it is identical with one very common in the Island of Ceylon, which is almost tame."

The extraordinary misconception as to the affinities of the creature displayed in the last sentence of this quotation will be apparent when we say that the scale-tailed squirrels—whether furnished with a flying-membrane or not—are absolutely restricted to Equatorial Africa, where not a single representative of the true flying-squirrels of Asia and Europe exists.

The reason why these two very dissimilar groups of animals are regarded in popular estimation as closely allied is, of course, due to the fact that both are furnished with expansions of skin by means of which they are enabled to take flying leaps from bough to bough. Such flying-membranes are developed in very few mammals, and the popular idea is that the presence of such a membrane must necessarily imply intimate affinity between all the forms in which it occurs. Hence not only are the African flying scale-tailed squirrels associated with the typical flying-squirrels, but the still more widely-separated flying-phalangers of Australasia are likewise regarded as members of the same group.

In making such associations the public fail to recognise that similar structures may be produced in totally different groups of animals owing to their living under similar special conditions, or having peculiar habits of the same nature. In external appearance rodents belonging to different families, such as squirrels and dormice, may be very much alike; and if certain members of each group had acquired the same mode of life as the flying-squirrels, their similarity would probably have become still more noticeable. For unless the whole skeleton of the fore-limbs be so modified as to form a wing, as in bats, it is difficult to see how ordinary mammals could be endowed with the power of taking flying-leaps save by the development of an expanse of skin along the sides of the body in the manner which obtains in the true flying-squirrels, the scale-tailed flying-squirrels, the flying-phalangers, and, it may be added, the flying-lemurs.

The development of flying-membranes in all these four groups of mammals has, in fact, taken place quite independently, and affords an interesting example of what is known as parallelism in development. Such parallelisms are due, so to speak, to the poverty of possibilities in the way of modification of animal structures. As already

A'.

B.

LIKE AND YET UNLIKE.

An Asiatic (A') and an African (B) Flying-Squirrel

(From Plates illustrating Papers by Mr. O. Thomas.)

said, the simplest and most obvious way of endowing an ordinary four-limbed mammal with the power of taking flying-leaps is by the development of lateral expansions of skin. Similarly, the only easily conceivable method by which a primitive short-limbed and many-toed hoofed mammal could be converted into one cut out for speed, like a horse or a gazelle, is by reducing the number of the digits and increasing the length of the lower segments of the limbs. Accordingly, we find parallelism in this respect between the horses and the zebras on the one hand, and the gazelles, antelopes, and deer on the other.

But the parallelism is by no means exact in this latter case, as indeed would be naturally expected if the lines of evolution were distinct; and the structure of the lower portion of the limbs of a horse differs essentially from the same part in a gazelle.

Neither is the parallelism exact in the case of the two groups of flying-squirrels. In the flying-squirrels of Europe and Asia, such as the one depicted on the left side of the plate, the flying-membrane, or parachute, is merely a lateral expansion of the ordinary skin of the body, which extends outwards between the limbs and terminates at the wrist and ankle. In addition to the two lateral membranes, there is a narrow and inconspicuous one passing from each cheek along the front of the shoulder to the front of wrist; and another, at least in the larger forms, connecting the two hind-legs and involving the base of the tail.

In general characters the parachute of the scale-tailed flying-squirrels of Africa conforms to the above type; and a superficial observer might say that the two were in all respects similar. A closer examination will, however, reveal the fact that the parachute in this group is supported by a process of cartilage projecting like a yard-arm from the elbow and extending to the edge of the membrane. As this is present in all the flying scale-tails (as we may call them for short, especially as they have no right at all to the title of squirrels) and absent in all the true flying-squirrels, it evidently indicates an important difference between the two groups.

A further important distinction between them is afforded by the presence on the under surface of the basal portion of the tail of a series of overlapping horny scales, from which the African group takes both its popular title of scale-tail, and its scientific name of *Anomalurus*. Evidently these scales are intended to aid in supporting the animals as they climb the boughs or stems of trees, and are thus strictly analogous to the stiff tail-feathers of woodpeckers.

Another important difference between the two groups is to be found in the structure of the crowns of their cheek-teeth. In ordinary squirrels the grinding surfaces of these teeth are surmounted by simple tubercles, which in some cases may be elongated into ridges. And a similar type of tooth-structure obtains in most of the flying-squirrels of Europe and Asia, although in the species shown in the plate the structure has become somewhat more complicated owing to the taller crowns of these teeth. In the scale-tails, on the other hand, a totally different type of tooth-structure obtains, the crowns of the molars being divided by transverse folds of enamel, after a fashion recalling that which obtains in certain South American rodents.

To the anatomist these differences are sufficient to render it quite certain that the scale-tailed flying-squirrels are, at most, but very remotely connected with their non-scaled namesakes of the northern hemisphere. The non-scientific person might, however, say that the "yard-arm" in the parachute and the scales on the tail are features which have been developed concomitantly with the acquisition of the parachute itself in certain species of flying-squirrels, and that, like the differences in the structure of the teeth, are of no particular importance one way or the other in regard to the affinities of the animals in which they occur.

A few years ago it would have been impossible to produce absolutely decisive evidence as to the futility of such specious arguments. Recently, however, there has been discovered on the west coast of Africa—that home of strange and primitive types of animal life—a rodent looking not unlike a large dormouse, which is really the "grandfather" of all the flying scale-tails. For this creature (known as *Zenkerella*), although without a parachute, has scales on its tail like *Anomalurus*, and teeth of the same type as the latter. Whether it is the actual form from which the flying scale-tails are descended, or whether it is itself a descendant of such ancestral form, may be left an open question, as it is one of no practical importance. But it may be taken as certain that the flying scale-tails, of which, by the way, there are two distinct generic types (*Anomalurus* and *Idiurus*), are the specialised descendants of a creature closely allied to, if not identical with, *Zenkerella*. It may further be affirmed with certainty that the evolution of the flying from the non-flying scale-tails has taken place in Africa. Whether, however, *Zenkerella* itself is an aboriginal African type, or an immigrant into the dark continent from the north, is a question not easy to answer at the present time.

Although the flying-squirrels of Europe and Asia have been known from time immemorial, their pedigree is not so easy to trace as is that of the scale-tails. Probably they were evolved from non-flying squirrels at an earlier date than that at which *Anomalurus* branched off from *Zenkerella* (or its prototype), as they appear to be represented by teeth in some of the earlier Tertiary deposits of Europe. It is therefore quite probable that even the generic types from which they trace their descent have died out. Nevertheless, it may be considered practically certain that they are descendants more or less nearly allied to the true squirrels of the genus *Sciurus*. Their pedigree is therefore wholly distinct from that of their reputed cousins the scale-tailed flying-squirrels of Equatorial Africa.

In appearance the true flying-squirrels, of which there are three distinct generic types, are very similar to ordinary squirrels, as indeed they are in their habits; their long flying leaps, during which they half float in the air by the aid of the parachute, being only an extension of the bounds taken by the ordinary red squirrel in its passage from tree to tree. Many of them are even more beautifully coloured than ordinary squirrels. Compared with the latter, flying-squirrels are more strictly nocturnal animals; and their shrill scream is familiar to all travellers in the wooded districts of the Himalaya as they are attracted by the light of the camp-fire.

The smallest members of the group are the pigmy flying-squirrels, typified by *Sciuropterus volans* of Eastern Europe and Siberia, and represented in North America by the closely allied *S. volucella*. They are pretty little creatures, with soft velvety fur, and enormous staring black eyes. In all the pigmy flying-squirrels the membrane connecting the hind-legs and the base of the tail is absent; but, in compensation, the tail itself is broad, flat, and laterally expanded, so as to form an efficient aid in flight.

The typical and larger flying-squirrels, formerly known as *Pteromys* but now called *Petaurista*, are confined to Europe and Asia, having no transatlantic representative, Unlike that of the pigmy flying-squirrels, the tail of these rodents is cylindrical and comparatively thin, while, as already said, the parachute is fully developed between the hind legs.

In the last and finest representative of all the flying-squirrels—the species shown on the left side of the accompanying plate—the writer has a special personal interest. About the year 1878, when in Srinagar, Kashmir, he purchased the skin of a large flying-squirrel from a *chamra-walla* (tanner), who stated that it came from Astor or Gilgit, and that he had never previously seen its like. In due course this skin was brought to England, and converted into a perambulator-rug, in which capacity it was in use for several years, on one occasion narrowly escaping complete destruction by the jaws of a favourite pug-dog. At this period, it may be mentioned that the writer was less well acquainted with mammals, so far as their exteriors are concerned, than he is at the present day. And although he had a suspicion that the skin in question was peculiar, no steps were taken to ascertain whether this was really the case. One day, however, in 1888, when paying a visit to the Natural History Museum, he was shown a living flying-squirrel from Astor, remarkable for its dark colour and bushy tail, which was pronounced to represent a then unknown species. A brief inspection was sufficient to render it evident that the skin serving as a perambulator-rug belonged to the same species as the living animal, although a much larger and finer individual. It was soon after presented to the Museum, and described, in conjunction with the complete specimen, not only as the type of a new species, but of a new genus, under the title of *Eupetaurus cinereus*. Owing to the splendid development of the tail in the flat skin, the figure of which a reproduction is given on the left side of the accompanying plate was partly drawn from that specimen.

The main reason for making the woolly flying-squirrel (as, from the nature of its coat, it has been called) the type of a genus by itself is afforded by the characters of its cheek-teeth, which differ from those of other members of the group by their tall crowns and imperfectly developed roots. This character indicates greater specialisation than the ordinary flying-squirrels. Unfortunately little or nothing is known as to the life-history of this splendid representative of the flying-squirrels, but there is some reason to believe that it dwells, at least to a certain extent, among rocks, rather than in trees.

Although they do not properly come within the scope of the present article, a few words may be said with regard to the flying-phalangers (the flying-squirrels of the colonists) of Australia, since in one respect they present a curious analogy with the flying-squirrels of the Old World. It need hardly be said that these Australian flying-phalangers are true marsupials, with a dentition resembling that of the ordinary phalangers, or, as they are locally called, opossums. The larger flying-phalangers, which constitute the genus *Petaurus*, are characterized by the full development of the parachute and the rounded bushy tail. As in the case of the Asiatic flying-squirrels, we are unable to point out the non-volant type of phalanger from which they are descended.

On the other hand, the beautiful pigmy flying-phalanger (*Acrobates*), which differs from the larger forms by the scantier development of its parachute, as well as by its tail being formed after the type of a feather—that is to say being flattened, with a line of hair along each edge—is evidently descended from the non-flying feather-tailed phalanger *(Distœchurus)*, or the immediate ancestor of the latter. In this case, therefore, we have an exact parallelism to the descent of the flying representatives of the scale-tails from the non-flying *Zenkerella*.

THE LUCID STARS.

By J. E. Gore, F.R.A.S.

The term "lucid" has been applied to the stars visible to the naked eye, without optical aid of any kind.* Many people think that the number of stars visible in this way is very large. But in reality the number visible to the naked eye is comparatively small. Some persons are, of course, gifted with very keen eyesight—"miraculous vision" it is sometimes called—and can see more stars than others; but to average eyesight the number visible in this way, and which can be individually counted, is very limited. The famous Hipparchus formed a catalogue of stars in the year 127 B.C. This presumably contained all the most conspicuous stars he could see in his latitude, and it includes only 1025 stars. Al-Sufi, the Persian astronomer, in his "Description of the Fixed Stars," written in the tenth century, describes the positions of only 1018 stars, although he refers to a number of other faint stars, of which he does not record the exact places. Pliny thought that about 1600 stars were visible in the sky of Europe.

In modern times, however, a considerable number of fainter stars have been recorded as visible to the naked eye. The famous German astronomer, Heis, who had keen eyesight, records the positions of 3903 stars north of the Equator, and 1040 between the Equator and 20 degrees south declination, or a total of 4943 stars between the North Pole and 20 degrees south of the Equator. This would, I find, give a total of about 7366 stars for both hemispheres if the stars were equally distributed. Behrmann, in his Atlas of Southern Stars, between 20 degrees south declination and the South Pole, shows 2344 stars as visible to the naked eye. This would give a total of 7124 for both hemispheres. The actual number seen by Heis and Behrmann in both hemispheres is 4943 + 2344, or 7287 stars. The Belgian astronomer, Houzeau, published a catalogue and atlas of the stars in *both* hemispheres, made from his own observations in Jamaica and South America, and finds a total of 5719 stars in the whole sky. As all these observers had good eyesight, we may take a mean of the above results as the total number visible to the naked eye in the whole star sphere. This gives 6874 stars, or in round numbers we may say that there are about 7000 stars visible to average eyesight in both hemispheres. This gives, of course, about 3500 stars to one observer at the same time at any point on the earth's surface.

As the whole star sphere contains an area of 41,253 square degrees, we have an average of one star to six square degrees. In other words there is, *on an average*, one lucid star in a space equal to about thirty times the area covered by the full moon! This result may seem rather surprising considering the apparently large number of stars visible to the naked eye on a clear night, but the fact cannot be denied. The stars are not, of course, equally distributed over the surface of the sky, but are gathered together in some places, and sparsely scattered in others, and this may perhaps help to give the impression of a greater number than there really are.

That the stars are of various degrees of brightness was recognised by the ancient astronomers. Ptolemy divided them into six classes, the brightest being called first magnitude, those considerably fainter the second, those much fainter still the third, down to the sixth magnitude, which were supposed to be the faintest just visible to the naked eye on a clear moonless night. Ptolemy only recorded whole magnitudes, but Al-Sufi, in the tenth

* Except concave spectacles used by short-sighted persons.

century, divided these magnitudes, for the first time, into thirds. Thus a star slightly less than an average star of the second magnitude he called 2—3, that is nearer in brightness to 2 than to 3; one a little brighter than the third he recorded as 3—2, or nearer to 3 than to 2, and so on. This method has been followed by Argelander, Behrmann, Heis, and Houzeau, but in the photometric catalogues of Harvard, Oxford, and Potsdam, the magnitudes are measured in decimals of a degree. This has been found necessary for greater accuracy, as the heavens contain stars of all degrees of brightness.

The term "magnitude" means the ratio between the light of a star of a given magnitude and that of another exactly one magnitude fainter. This ratio has been variously estimated by different astronomers, and ranges from 2·155, found by Johnson in 1851, to 3·06, assumed by Pierce in 1878. The value now universally adopted by astronomers is 2·512 (of which the logarithm is 0·4). This number is nearly a mean of all the estimates made, and agrees with the value found by Pogson in 1854 by means of an oil flame, and by Rosen with a Zöllner photometer in 1870. It simply means that an average star of the first magnitude is 2·512 times the brightness of a star of the second magnitude; a star of the second, 2·512 times brighter than one of the third, and so on. This makes a star of the first magnitude just 100 times brighter than one of the sixth.

There are several stars brighter than an average star of the first magnitude, such as Aldebaran. These are Sirius, which is nearly 11 times brighter than Aldebaran (according to the revised measures at Harvard); Canopus, the second brightest star in the heavens, and about two magnitudes brighter than Aldebaran; Arcturus, Capella, Vega, Alpha Centauri, Rigel, Procyon, Alpha Eridani, Beta Centauri, and Alpha Orionis. Al-Sufi rated 13 stars of the first magnitude, visible at his station in Persia, and Halley enumerates 16 in the whole sky. According to the Harvard photometric measures, there are 13 stars in both hemispheres brighter than Aldebaran, which is rated 1·07.

As average stars of the different magnitudes the following may be taken as examples, derived from the Harvard measures: First magnitude, Aldebaran and Spica; second magnitude, β Aurigæ and β Canis Majoris; third magnitude, ι Aurigæ and β Ophiuchi; fourth magnitude, θ Herculis and ε Draconis; and fifth magnitude, ρ Ursæ Majoris and ω Sagittarii. Stars of about the sixth magnitude are, of course, numerous, and lie near the limit of naked-eye vision for average eyesight, although on clear moonless nights still fainter stars may be "glimpsed" by keen-eyed observers.

The stars have been divided into groups and constellations, now chiefly used for the purpose of reference, but in ancient times they were associated with the imaginary figures of men and animals, etc. The origin of these constellation figures is doubtful, but they are certainly of great antiquity. Ptolemy's constellations were 48 in number, but different writers from the first century B.C. give different numbers, ranging from 43 to 62. Bayer's Uranometria, published in 1603, contains 60, 12 new constellations in the Southern Hemisphere having been added by Theodorus to Ptolemy's original 48.

The figures representing the constellations were originally drawn on spheres, or celestial globes as they are now called. The ancient astronomers attributed the invention of the sphere to Atlas. It seems certain that a celestial sphere was constructed by Eudoxus in the fourth century B.C. Strabo speaks of one made by Krates about the year 130 B.C., and according to Ovid, Archimedes had constructed one at a considerably earlier period. None of these ancient spheres have been preserved. There is, however, in the Vatican a fragment in marble of a Greco-Egyptian planisphere, and a globe in the museum of Arolsen, but these are of much later date. Our knowledge of the original constellation figures is derived from the accounts given by Ptolemy and his successors, and from a few globes which only date back to the Arabian period of astronomy. Among the Arabian globes still existing the most famous is one made of copper, and preserved in the Borgia Museum at Velletri in Italy. It is supposed to have been made by a person called Caisar, who was executed by the Sultan of Eygpt in A.D. 1225. The most ancient of all is one discovered some years ago at Florence. It is supposed to date back to A.D. 1081, and to have been made by Meucci. There is also one in the Farnese Museum at Naples, made in A.D. 1225. Of modern celestial globes the oldest is one made by Jansson Blaeu in 1603. This gives all the constellations of the Southern Hemisphere as well as the Northern.

Ptolemy's figures of the constellations were restored by the famous painter Albert Durer, of Nüremberg, in 1515. The figures on modern globes and maps have been copied from this restoration. Durer's maps are now very rare.

In 1603 an atlas was published by Bayer. This was the first atlas to show the southern sky, and the first to designate the brightest stars by the letters of the Greek alphabet. Flamsteed published an atlas in 1729. Maps and catalogues of the lucid stars have been published in recent times by Argelander, Behrmann, Heis, Houzeau, Proctor, and others. Of these Heis' is, perhaps, the most reliable, at least so far as accurate star magnitudes are concerned. Houzeau shows *both* hemispheres, all the stars having been observed by himself in Jamaica and South America. Behrmann's maps are confined to the Southern Hemisphere, between the South Pole and 20 degrees south of the Equator. The maps of the *Uranometria Argentina* made at Cordoba in the Argentine Republic, show all the southern stars to the 7th magnitude, but many of these are beyond the reach of ordinary eyesight.

It is a well-known fact that the planets Venus and Jupiter are bright enough to form shadows of objects on a white background. It has also been found that the brightest stars, especially Sirius, are sufficiently brilliant to cast shadows. Kepler stated that a shadow was formed by even Spica, but I am not aware that this has been confirmed by modern observations.

There are some remarkable collections or clusters of stars visible to the naked eye, of these the Pleiades are probably the best known. To ordinary eyesight 6 stars are visible, but Möstlin, Kepler's tutor, is said to have seen 14 with the naked eye, and some observers in modern times have seen 11 or 12. Other naked-eye clusters are the Hyades in Taurus, called *Palilicium* by Halley, and the Præsepe, or Bee-Hive in Cancer. Of larger groups, the Plough or Great Bear, Cassiopeia's Chair, and Orion are probably known to most people.

Many of the lucid stars are double, that is, consist of two components, but most of these are only visible in powerful telescopes. There are, however, a few objects visible to the naked eye as double, and these have been called "naked-eye doubles," although not strictly double in the correct sense of the term. Ptolemy applied the term double to the star ν Sagittarii, which consists of two stars separated by a distance of fourteen minutes of arc, or about half the apparent diameter of the moon. According to Riccioli, Van der Hove saw two naked-eye doubles, one in Capricornus, 5 to $5\frac{1}{2}$ minutes distant, and the other in the Hyades, $4\frac{1}{2}$ or 5 minutes apart. The one in Capricornus was probably α, and the one in the Hyades θ Tauri. The middle star in the tail of the Great Bear, or handle of the Plough, has near it a small star, Alcor, which to many eyes is distinctly visible without optical aid. The famous Belgian astronomer, Houzeau, who seems to have had excellent sight, saw the star κ Tauri double, and 51 and 56 Tauri separated, also ι Orionis, and others.

Many of the stars are variable in their light, and several hundred of these curious and interesting objects are now known to astronomers. In a few of these the light changes may be followed with the naked eye. It is an interesting question whether any of the lucid stars have disappeared or changed in brightness since the early ages of astronomical observations. Al-Sufi failed to find seven of Ptolemy's stars, and Ulugh Beigh, comparing his observations with the catalogues of Ptolemy and Al-Sufi, announced twelve cases of supposed disappearance. Some of these may, however, be due to errors of observation. Montanari, writing in 1672, mentions two stars as having disappeared, namely β and γ of the constellation Argo, but these stars are now visible in the positions originally assigned to them.

In a careful examination of Al-Sufi's description of the stars written in the tenth century, and a comparison with modern estimates and measures, I have found several very interesting cases of apparent change in the brightness of the lucid stars. Al-Sufi was an excellent and careful observer, and as a rule his estimates agree well with modern observations. We can therefore place considerable reliance on his estimates of star magnitudes. "The Story of Theta Eridani" has been well told by Dr. Anderson in KNOWLEDGE for July, 1893, and there seems to be no doubt that this southern star, which is now only of the third magnitude, was a bright star of the first magnitude in Al-Sufi's time! The following are other interesting cases of apparent change which I have met with in my examination of Al-Sufi's work. The Pole Star was rated third magnitude by both Ptolemy and Al-Sufi, but it is now of the second magnitude, or a little less. The star γ Geminorum was rated third magnitude by Ptolemy and Al-Sufi, or equal to δ Geminorum, but γ is now of the second magnitude, and its great superiority in brightness over δ is noticeable at a glance. Another interesting case is that of ζ and o Persei, two stars which lie near each other, about seven degrees north of the Pleiades. Al-Sufi distinctly describes these stars as *both* of the 3—4 magnitude; but Argelander, Heis, and the photometric measures at Harvard agree in making ζ about one magnitude brighter than o. The stars being close are easily compared, and their present great difference in brightness is very noticeable. This is one of the most remarkable cases I have met with in Al-Sufi's work, and strongly suggests variation in o, as ζ is still about the same brightness as Al-Sufi made it. The identity of the stars is beyond all doubt, as Al-Sufi describes their positions very clearly, and says there is no star between them and the Pleiades, a remark which is quite correct for the naked eye. The remarkable decrease in brightness of β Leonis (Denebola) since Al-Sufi's time has been considered in my paper on "Some Suspected Variable Stars" (KNOWLEDGE, August, 1899). That it was a bright star of the first magnitude is fully proved by the observations of Al-Sufi and Tycho Brahe. These were careful and accurate observers, and they could not have been mistaken about a star of the first magnitude. β Leonis is now fainter than an average star of the second magnitude, and there can be no reasonable doubt that it has faded considerably since the tenth century.

There are some other discrepancies between Al-Sufi's observations and modern estimates, but the above are perhaps the most remarkable. With reference to lucid stars not mentioned by Al-Sufi, he has not I think omitted any star brighter than the fourth magnitude in that portion of the sky visible from his station. There are, however, a number of stars between the fourth and sixth magnitude which he does not mention. Of these the brightest seem to be ϵ Aquilæ, ρ and μ Cygni, and ζ Coronæ Borealis.

With reference to the distribution of the lucid stars in the sky there seems to be a well-marked tendency to congregate on the Milky Way. It is a remarkable fact that of the 15 brightest stars in the heavens, no less than 11 lie on or near the Milky Way, although the space covered by the Galaxy does not exceed one-fifth or one-sixth of the whole sky. From a careful enumeration of the stars in or near the Milky Way which I made some years ago, I found that of stars brighter than the fourth magnitude there are 118 on the Milky Way out of a total of 392, or about 30 per cent. From the Southern catalogue known as the *Uranometria Argentina*, Colonel Markwick, F.R.A.S., found 121 out of 228 stars to fourth magnitude, or a percentage of 53 per cent. These results seem to show some intimate relation between the lucid stars and the Galaxy.

ASTRONOMY WITHOUT A TELESCOPE.

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

XI.—MORNING AND EVENING STARS.

IT is one of the necessary penalties of the modern tendency towards city life that we are dissociated more and more from that close intercourse with nature which was open to our forefathers. How few of us ever care to watch that great spectacle which was to them so full of wonder and of awe, the silent, ceaseless procession of the starry heavens! It was not merely the sight of the thousand flashing gems of the midnight sky that impressed them, or their differences of colour and lustre, or the weird manner in which they were distributed; there was something more striking than all this, and that was their ceaseless movement. There was the wonder; that motion was so stately, so regular, so unceasing. "Without rest, without haste" they moved; no star ever left its appointed place in the celestial host, nor ever strayed from its appointed path. It was a nightly miracle, a miracle both of order and power. The thoughts to which it gave rise lay at the root of many an ancient myth, and inspired many a poetic outburst, chief amongst which stands the grand 19th Psalm. Nor, though the secret of that regular motion is understood to-day, is the sight of the movement of the vast cosmical machine in the least less impressive even now to any mind that can rise to some slight realisation of its true meaning.

But the observers of those early ages had other thoughts beside those of awe and wonder as they contemplated the nightly march of the heavenly host; there came a time when they had familiarised themselves with the different stellar groupings, and they saw that different constellations ruled the night watches at different seasons of the year.

After a long night watch in which the stately march of the heavenly host has been followed hour after hour, some stars moving round the pole in narrow circles, others passing out of view in the west, whilst new ones are ever mounting upward from the under world in the east, there comes a time when a change begins to be perceptible in the latter quarter. Little by little the eastern sky begins to brighten and the stars to pale, and now perchance it may be that a star more magnificent than any that has shone the long night through, comes upward, queen of the night, as the night is coming to an end. As it rises higher, so the glow in the east becomes brighter, and the fainter stars die out, until at length all have disappeared in the increasing daylight and the sun itself arises, the bright herald which preceded it being the only one of all the starry company that remains visible till the sun's appearance.

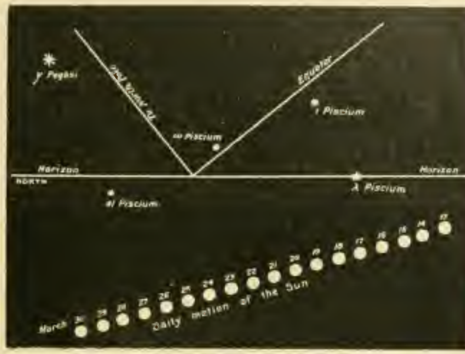
The planet Venus is the only object that in this completest manner can act as the forerunner of the sun, and it rightly, at such seasons, has a special claim to the title of the "Morning Star." But it is only now and then that Venus is so placed as thus to act as the solar herald. At other times the *rôle* has to be filled by stars of a meaner rank. But it is well worth noting what stars are the last to rise before the dawn drowns them with its growing light. The next morning it will be found that those same stars are visible just a little longer, and the next morning longer still, and so on, until some other star shows itself as the one to climb up from the eastern horizon just before the opening daylight becomes strong enough to overcome its shining.

Such stars are each in their turn "morning stars," and their first appearance in the faint dawn-glow of the east before sunrise is the "heliacal rising" which was made much of by ancient astronomers and poets. Not without reason, for it is an observation of very considerable exactness, and one which requires absolutely no instrument; not even the simple one of an obelisk or an upright spear, still less of the solid masonry of a "solstitial" or "equinoctial temple," or the huge trilithons of a Stonehenge. And it fixes the return of the sun to the same part of the heavens at the end of a year quite as exactly as those more cumbrous contrivances could do, if indeed they ever were used for such a purpose.

Corresponding to the "morning stars" are the "evening stars," the stars which are seen in the western twilight just before they set; the gathering darkness permitting them to be just glimpsed for a minute or two before they follow the departing sun down to the under world. This constitutes their "heliacal setting," and its observation supplements that of the "heliacal rising."

All stars are not by any means equally suitable for observation of their heliacal risings and settings. It is of course clear to begin with that the circumpolar stars, the stars which never set, are quite useless in such a connection. Nor are the stars in the extreme south, which only rise at the best a few degrees above the horizon, and only remain visible a very few hours, well suited for the work. The best stars are those which are not situated at any very great distance from the equator, either north or south, but which lie between the tropics of Cancer and Capricorn. Rigel, Sirius, Procyon, Arcturus, Alpha Serpentis, Alpha Ophiuchi are fairly well placed for observation in England, both at rising and setting, but as a general rule we may take it that the time of the spring equinox is the best for observing heliacal settings, and that of the autumnal for observing heliacal risings. The reason of this will be seen at once from the accompanying diagram, which represents the effect of the sun's motion in declination at setting, at the spring equinox; at the autumnal equinox the conditions are, of course, exactly reversed.

If the sun moved always in the equator, then a star which rose on one day at precisely the same time as the sun would rise about 4 minutes earlier than the sun on the next, and so on day by day. But at the time of the spring equinox, the sun is moving northwards at the rate of about 24 minutes of declination every day. Consequently the sun rises about $2\frac{1}{3}$ minutes earlier every day, and the stars which rise at dawn only gain therefore upon the sun 4 m. $-$ $2\frac{1}{3}$ m.; that is to say, $1\frac{2}{3}$ minutes. If the star is north of the equator, the sun is also coming nearer to it day by day, and hence that region of the sky becomes brighter and brighter at dawn. The result is that there may readily be a good deal of uncertainty about the determination of the day of the heliacal rising of such a star under these conditions. For the setting, the condi-



Positions of the Sun below the East horizon, near the Spring Equinox, at the rising of λ Piscium.

tions are reversed. If the sun were always in the equator, a star which set with the sun one day would set 4 minutes before it the next, and so on day by day. But since the sun is moving northward at the spring equinox, it sets about $1\frac{2}{3}$ minutes later each day, and the star therefore would set before the sun 4 m. $+$ $1\frac{2}{3}$ m., or $5\frac{2}{3}$ minutes the

Positions of the Sun below the West horizon, near the Spring Equinox, at the setting of ι Piscium.

next night, and so on night after night. If the star was south of the equator, the sun would be moving away from it in declination, and under these circumstances we should get the sharpest determination of the date of heliacal setting. So the autumnal equinox gives the best opportunity for determining heliacal risings, specially for stars north of the equator, and the worst time for observing heliacal settings, especially for stars south of the equator.

It follows from these considerations that the Pleiades, in spite of the frequent reference to their heliacal rising in classical poetry, were not well placed for this observation, for during the 5000 years that astronomy has been in active operation as a science, they were never so far from the vernal equinox as at present. It must, however, be borne in mind that the nearer to the equator the place of observation, the more exactly could the observation of heliacal rising be made. For the nearer the equator is approached, the more nearly are the apparent paths of the sun and stars perpendicular to the horizon. They, therefore, seem to rise in the sky much more sharply, and dawn and twilight last for a much shorter space of time. A similar remark applies in its degree to Sirius, which, 5000 years ago, would have been by no means a very good star to observe at heliacal rising here in England. But the land where Sirius was made much of for this purpose was Egypt, the most southern of all the ancient civilisations, and in that marvellous climate the star may often be seen now to rise sheer from the waters of the Red Sea. Under such circumstances the return of the year could be fixed with all desired exactness by the rising of Sirius, even when it was on the vernal colure.

There is a great interest for those who care to try to enter into the thoughts and conditions of the past in repeating for oneself the very observations which were so all-important thousands of years ago. And there is a real value in repeating them to-day. If three or four observers were independently to observe the heliacal risings and settings of some two dozen zodiacal stars for three or four years, we should gain a great deal of needed information as to the actual amount of precision of which the method is capable, and some needed light would be thrown upon its practical efficiency. But more than this, the work would prove very effective in teaching the observer to pick up quickly minute points of light in a bright sky. This training would be found afterwards of great value in more ambitious fields of astronomy. The variable star observer would find it of use in enabling him to discount the effect of bright moonlight on his observations; the double star observer would find his eye quickened to detect a faint companion in the glare which a bright star gives in the field of a great refractor.

But more than this, the work affords a chance—a rare one it must be admitted, but a chance not to be despised —of making a discovery of a most interesting kind. Occasionally comets passing through our system so approach us as not to be seen until they are close to the sun, and these are usually comets of exceptional interest, both from the character of their orbits and from their physical behaviour. Such objects the persistent observer of heliacal risings and settings is—from the nature of his work, and from the special acuteness in detecting objects in the twilight sky which it will have given to him—the most likely to be the first to discover. The great comet of the autumn of 1882, for instance, was first seen at sundown, the great southern comet of 1901 was detected just before sunrise; in both cases only a very short time before the comet passed into conjunction with the sun, and was temporarily lost to view. In both cases a regular "heliacal" observer would have stood a good chance of being two or three days ahead of anyone else in the discovery, to the gain of his own reputation and of astronomical science.

The three stars mentioned earlier, Sirius, Procyon and Rigel, may be observed to rise during the latter half of August; their settings fall in April and May. They are thus emphatically winter stars, Rigel coming to opposition on December 11th, Sirius on December 31st, and Procyon on January 12th. In the case of these stars, the opposition falls nearly midway between the date of rising and that of setting. Not so with stars near the equinoctial colures. Thus Spica rises at the end of October, comes to opposition on April 12, and sets in the middle of August. Hamal, on the other hand, rises near the end of May, comes to opposition on October 26, and sets in the middle of April. The Pleiades, too, which Hesiod reports as being invisible for forty days, are now invisible here in England for over sixty, from the end of April to the beginning of July, but the date of conjunction does not fall in the middle of this period but on May 19.

A very interesting side question would probably arise in the course of the systematic observation of heliacal phenomena, and that is the influence of colour on the visibility of stars of a given brightness in a bright sky. Orion and the neighbourhood are particularly rich in stars suitable for such a comparison. The orange tint of Betelgeux, the golden colour of Aldebaran, the slight suspicion of green about Bellatrix, the steel-blue of Alnath and of the giant Sirius, the white of Procyon, and the contrast which is so obvious between the tints of Castor and Pollux, afford ample materials for a very delicate and interesting research, and one which it still remains to make.

Stars for Heliacal Observation.

At Setting.		At Rising.	
February—	ϵ Pegasi, *Enif.*	August—	β Orionis, *Rigel.*
March—	α Pegasi, *Markab.*		α Canis Minoris, *Procyon.*
	γ Pegasi, *Algenib.*		α Canis Majoris, *Sirius.*
	α Piscium, *Okda.*		α Cancri.
April—	α Arietis, *Hamal.*	September—	α Leonis, *Regulus.*
	β Orionis, *Rigel.*		β Leonis, *Denebola.*
	η Tauri, *Alcyone.*	October—	α Bootis, *Arcturus.*
May—	α Canis Majoris, *Sirius.*		α Virginis, *Spica.*
	α Tauri, *Aldebaran.*	November—	α Serpentis, *Unuk.*
	α Canis Minoris, *Procyon.*		α Ophiuchi, *Rasalague.*

THE USE OF HAND TELESCOPES IN ASTRONOMY.

By Cecil Jackson.

II.—THE SUN.

Before treating of the sun itself, it will be desirable to consider the methods of observing it. For a small pocket telescope a cap containing a piece of very dark green glass will answer well. The glass should be so dark that the outlines of buildings are invisible through it when it is held up to the eye. A small telescope requires as dark a glass as a large one. Do not on any account be persuaded into having a light sun-glass on any telescope, however small, as the use of such a glass is very trying to the eye, except in a smoky or dull atmosphere.

Another way of viewing the sun is to fix a piece of paper in the sunshine, with the sun shining squarely on it. The paper may be pinned to a board, and the board reared up on a chair in such a way that the pins, if truly perpendicular to its surface, cast no shadow on the paper. Stand facing the paper, and hold the telescope—drawn out to its full length—with its eye-end a few inches away from the paper, so that a circular shadow is cast, in which case the telescope is pointing at the sun, and a bright patch of light will appear on the paper. Slide the eye-tube of the telescope inwards until the patch of light has a sharp outline, and if there are any large spots upon the sun they will appear in the Solar image cast on the paper. When once the sun's image has been thrown on the paper, the telescope may be grasped by the left hand in such a way as to cast a margin of shadow around the image of the sun, or a cardboard disc may be fitted round the telescope tube for the same purpose. This will make the Solar image appear more pronounced.

More detail can, however, be seen by using a dark glass, and looking directly through the telescope at the sun. On a telescope not exceeding two inches in aperture there is no fear of the glass cracking, especially if the sun is not observed when high up in the sky, as it is at noon in summer, for example. In observing the sun when high up, it is a good plan to turn the telescope aside every few seconds so as to prevent the dark glass from becoming hot.

I shall now begin to describe the details of the sun as seen in the telescope.

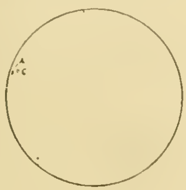


Fig. 4.

Fig. 4 represents the sun as seen at about 1h. 1m. p.m., June 24, 1899. A represents white marking seen near the sun's limb. B is a small spot. C is a large spot, surrounded by a grey border called a "penumbra" to distinguish it from the dark centre or "umbra." My $1\frac{5}{8}$-inch telescope with its own terrestrial eye-piece was used in making this observation. The pancratic draw was set to the power 30 line, so as to give a magnifying power of 30 diameters.

Fig. 5.

Fig. 5 represents the sun as seen on Aug. 5, 1893. Power 35 on the $1\frac{5}{8}$-inch telescope used. Time, about 4h. 9m. p.m. This picture gives an idea of the sun's appearance when largely spotted. As an instance of the difference in the number of days on which no spots are observed on the sun in different years, I may mention that I observed no spots on the sun on eight occasions in 1898, whilst in 1899 the days on which no spots were observed were about thirty-two.

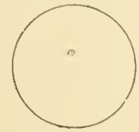


Fig. 6.

Fig. 6 represents the sun as seen with a 1-inch pocket telescope at about 2h. 41m. p.m., Friday, Oct. 28, 1898. A dark glass was, of course, used on the telescope. On very clear days the sun may be seen, if a 2-inch telescope is used, to have a curdled appearance. I have sometimes seen this appearance with my $1\frac{5}{8}$-inch telescope. Tapping the telescope with the fingers, or moving it backwards and forwards may assist to make the curdling visible.

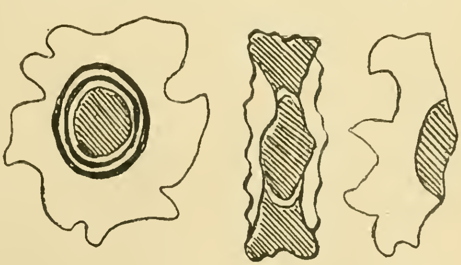
Letters.

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

THE FLIGHT OF A HAILSTONE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In reference to the interesting paper on "The Flight of a Hailstone," in the February number of Knowledge, I venture to send you the enclosed sketches of some hailstones which fell here on June 13th, 1900. They fell in large numbers at the end of a very severe thunderstorm. The area over which they fell was limited to a few miles radius. In form they resembled a cart-wheel, being thickest at the circumference. The alternate clear and opaque rings were very distinctly marked. The largest measured one and a half inches in diameter, and the weight, after the stones had been lying, perhaps, a quarter of an hour on the ground, was one-third of an ounce. Somewhere about '65, a similar storm of hail occurred in Herefordshire, but the shape of the stones was different, each stone being largest in the centre, and



Hailstone.—Actual size. Section. Side view of broken stone.

diminishing to the circumference, resembling not a cart-wheel but an oyster. Some of the largest of these latter stones weighed an ounce.

South Leigh Vicarage, Witney, Oxon. Arthur East.

THE USE OF HAND TELESCOPES.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In the article "The Use of Hand Telescopes in Astronomy" in this month's Knowledge it is said that in order to increase the power of the instrument it is desirable to remove the lens next but one to the eye end. I have tried this with my telescope, which is a three-draw one, $1\frac{3}{4}$ in. object glass, and found the result tolerably satisfactory.

However, a much better plan is to remove the third lens, *i.e.*, the next but one to the object glass, the result was a surprisingly good one, every part of the field of view available for distinct vision, and the magnifying power about half as large again.

The holding and steadying of a small telescope out of doors is a great trouble even for ordinary use, and always a failure when observing celestial objects. So I got a clip made with a screw attached to it, by means of which I can steady the telescope, and move it freely in every direction.

I also have an astronomical telescope with a 3 in. object glass and a power of 100 diameters, and I find it often useful to remove the inner one of the two lenses which form the eyepiece. The field of view becomes smaller, but the magnifying power is very much increased thereby, and it enables me to see comparatively very small objects on the moon, and even divide the rings of Saturn.

Walthamstow, February 10th, 1902. M. Hare.

[I do not agree with Mr. Hare as to the great advantage to be attained by removing the third lens from the eye end —the next but one to the object glass—though the field is better than when the lens next but one to the eye end is removed. But the advantage of using some means of steadying the telescope is very great. Only, though this is but a verbal criticism, it could scarcely then be described as a "hand telescope."—E. Walter Maunder.]

A METHOD OF GENERATING ACETYLENE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The following method of generating acetylene in small quantities, which other boys and myself have used for some time in the Chemical Laboratory, at Mill Hill School, may be of interest to readers of Knowledge.

Place a few lumps of calcium carbide in a six ounce flask or Woulff's bottle, and cover them with methylated spirits. If diluted hydrochloric acid (1 : 2 water) be slowly dropped into the bottle by means of a stoppered funnel, a steady flow of acetylene gas is evolved, which can be collected, like hydrogen, over water.

The equation is—

$$Ca\,C_2 + 2\,H\,Cl = Ca\,Cl_2 + C_2\,H_2.$$

The advantages of this method as compared with that given in text-books (dropping water upon dry calcium carbide) are—

(1) A steady even flow, completely under control, instead of a rapid, brief evolution;

(2) A liquid mass of calcium chloride left, easily washed out of the bottle, instead of a hard cake of slaked lime.

It was not found practicable to keep the calcium carbide under alcohol for any length of time, as the mixture slowly evolved acetylene.

It is possible that the method may be of practical utility for cyclists' lamps, although the use of acid might necessitate some alteration in the material of these.

Mill Hill School, N.W. R. Knowles.

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

Possible Breeding of the Eared Grebe in Oxfordshire (*Ibis*, January, 1902, p. 165).—Mr. O. V. Aplin writes to the *Ibis* with regard to a pair of Eared Grebes which were shot on a large pond near Bloxham on September 19th, 1899. Mr. Aplin gives reasons for supposing that these birds may have remained to breed in England, and that they were not merely migrants.

Nutcracker in Herefordshire (*Zoologist*, January, p. 25).—Mr. H. E. Forrest records that a Nutcracker was obtained in September last near Hereford. In view of the irruption of the Siberian form of the Nutcracker into Western Europe in the autumn of 1900 (*see* Knowledge, 1900, p. 256; 1901, pp. 117 and 281), it would be interesting to know if this specimen was of the slender-billed Eastern form.

King-Eider in Fifeshire (*Zoologist*, January, p. 27).—Mr. B. B. Riviere records that a male King-Eider was shot on a moor in Fifeshire on June 15th, 1899. This Arctic bird seldom visits our islands.

Tengmalm's Owl in Suffolk (*The Field*, February 1st, p. 177).—Mr. F. W. Frohawk here gives an account of two specimens of Tengmalm's Owl which were picked up in an exhausted state at the end of last October in Suffolk. One of the birds was picked up by Captain Lawrence Grubbe on the beach at Southwold on October 30th. The other bird was found in the gardens of the Grand Hotel in the same town probably about the same date. Both birds have been kept alive, and are remarkably tame; but neither give any indications of having been in captivity. Tengmalm's Owl is a rare visitor to the British Islands, and most of the records have been from the Eastern Counties during the autumn or winter. This Owl is an inhabitant of the pine forests of northern regions, but it is also found in the pine-clad mountains of the south; and it migrates to a considerable extent during the autumn and spring.

⁂ *During the absence from England of* Mr. Harry F. Witherby, *who has started on an Ornithological Expedition to South-West Persia, these Notes will be conducted by* Mr. W. P. Pycraft, *to whom all communications should be addressed at the Natural History Museum, Cromwell Road, London, S.W.*

NOTES.

Astronomical.—From measurements made at the Lick and Yerkes Observatories, Prof. Barnard has deduced the following values for the diameters of planets and satellites:—

	Miles.		Miles.
Mercury	2,965	Pallas	304
Venus	7,713	Juno	120
Mars, equatorial	4,352	Vesta	239
Mars, polar	4,312	Jupiter, equatorial	90,190
Ceres	477	Jupiter, polar	84,570

	Miles.		Miles.
Jupiter, Satellite I. ...	2,452	Saturn, polar	69,780
Jupiter, Satellite II. ..	2,045	Saturn, Satellite Titan	2,720
Jupiter, Satellite III.	3,558	Uranus, equatorial .	35,820
Jupiter, Satellite IV. ..	3,345	Uranus, polar ...	33,921
Saturn, equatorial ...	76,470	Neptune	32,900

A rough attempt to determine the total light of the stars by direct observation has been made by Prof. Simon Newcomb, who is inclined to regard this quantity as among the most important fundamental constants of astrophysics. The methods of observation were extremely simple, consisting chiefly of comparing sky illumination with the image of a star of known magnitude diffused into a disc by a suitable concave lens, and reduced by means of dark glasses when necessary. It was found that the total light of all the stars is about equal to that of 600 stars of zero magnitude, with a probable error of one-fourth of the whole amount. A positive correction, however, is more probable than a negative one, and the number may possibly be greater than 800. From statistics relating to the numbers of stars and nebulæ, it will be remembered that Mr. Gore concluded that the total light was equal to 589 stars of zero magnitude.

We learn from Bulletin No. 14 of the Lick Observatory that two oval nebulous rings surrounding Nova Persei were photographed as far back as March 29th, 1901, although the plate was only exposed for ten minutes as compared with the ten hours which now appears to be necessary. The rings were then quite small, but it is considered that the later rings may be regarded as having been produced by expansion outwards from the Nova. Assuming the identity of the earlier and later forms, the daily radial rate of motion is found to be 2″·62 in the south-west quadrant, and 3″·00 towards the north. At this rate the nebulous matter would have been coincident with the Nova on February 16th or 17th, and some of it might be expected to reach the solar system in about 250 years if the same rate of expansion is maintained, supposing that there is actual translation of the nebulous material.—A. F.

BOTANICAL.—The question of the systematic position of the Nymphæaceæ—whether they should be included in the Dicotyledons or the Monocotyledons—has already been discussed by several botanists. It is brought forward again in a paper by Mr. H. L. Lyon, which appears in the *Minnesota Botanical Studies*, Series 2, Part V., where he records his "Observations on the Embryogeny of *Nelumbo*." In Bentham and Hooker's system the Nymphæaceæ are placed in the Ranales, between the Berberidaceæ and the Sarraceniaceæ. Mr. Lyon shows that *Nelumbo*, both in its anatomy and embryogeny, conforms to the type of the Monocotyledons; that there is only one cotyledon, the two fleshy lobes of the embryo, described by some botanists as cotyledons, really arise through the bifurcation of the originally single cotyledon; and finally, that the order to which it belongs should be included in the Monocotyledons, in the series Helobiæ, which includes *Potamogeton*, *Alisma*, *Butomus*, &c. Referring to the subject in the January number of the *American Naturalist*, Prof. D. H. Campbell points out that the Lesser Celandine (*Ranunculus Ficaria*) has only one cotyledon, and that the Ranunculaceæ, resembling in their flowers those of the Alismales, are amongst the anomalous Dicotyledons.

The origin of the stipules in *Liriodendron*, represented by the well-known tulip-tree of our gardens, is the subject of a paper in the *Bulletin of the Torrey Botanical Club*, of September, 1901, by Mr. E. W. Berry. The writer has examined a great number of leaves of *L. tulipifera*, and taking into account the leaf of a fossil species recently described by Dr. A. Hollick, and the leaves of allied genera of Magnoliaceæ, supports Dr. Hollick's opinion that "the large fugacious stipules of our living tulip-tree might represent former leaf-lobes, which, becoming separated, formed basilar lobes, then winged petioles, and finally the modern stipules."—S. A. S.

ZOOLOGICAL.—On the evening of Friday, January 7th, Professor E. Ray Lankester, Director of the Natural History Branch of the British Museum, delivered at the Royal Institution a lecture on the okapi, illustrated by a life-sized coloured sketch of that remarkable mammal. The relationship of the okapi to the giraffe and the extinct *Helladotherium* and its allies was fully discussed.

Allusion has been already made in these columns to the splitting-up of the puma into a number of so-called species. Recently Mr. E. A. Mearns (*Proc. Washington Academy*, Vol. XIV., p. 137) has followed the same course in the case of the jaguar. Undoubtedly different local forms and phases of both the jaguar and the puma do exist, and, if it be thought desirable, there can be no objection to indicating them by sub-specific or varietal names. When, however, it comes to calling them species the case assumes a very different aspect, for we are then in danger of losing sight of the all-important fact that these two types of cat range over a very large portion of the American continent (the puma much farther than the jaguar). In return for this loss, we gain—nothing, if not worse than nothing. It is a case of losing sight of the wood for the trees, and the sooner this practice of excessive species-making on the part of specialists is discouraged, the better it will be for the true interests of natural history. No advantage whatever can be urged in favour of the practice, while there is much that can be said against it.

Had space permitted, we should have called attention at an earlier date to a very interesting paper by Miss D. Bate on the mammals discovered by herself in a cave in the Wye Valley near the Forest of Dean, which appeared in the *Geological Magazine* for last year. The special interest connected with these remains is that they are chiefly those of bats, insectivores, and rodents, and that many of the latter belong to Arctic and Alpine types at present unknown in Britain. The species include the Norwegian and the banded lemming, the pica, the northern vole, the Alpine vole, and the Continental field-vole, as well as several still existing in Britain. Hitherto, almost the only evidence of the former presence in Britain of the Arctic and the Alpine vole has been afforded by remains from Somersetshire and Wiltshire.

The theory that the horns of the big-horn wild sheep (*Ovis canadensis*) act the part of megaphones in conveying sound to the ears of their owners, which was discussed at a recent meeting of the Linnean Society, has formed the subject of correspondence in the columns of *The Field*. One observer writes very strongly against the likelihood of the theory being true, and some of his arguments will be found very difficult to controvert. It is a pity, however, that he uses the term *helix*, when he means *pinna*, or *conch*.

In a paper on a collection of mammals from Shendi, on the Upper Nile, published in the December issue of *Novitates Zoologicæ*, Mr. W. E. De Winton names a spiny mouse *Acomys witherbyi*, in honour of Mr. H. F. Witherby, by whom the type specimen was collected near Khartum. A new species of gerbil (*Gerbillus watersi*) is likewise named in the same communication.

With the exception of a few forms which entered North America during the Pliocene and Pleistocene epochs, the great extinct edentates allied to *Megalotherium* and *Mylodon* have hitherto been considered characteristic of South America, where they appear to have died out within the historic period. Monsieur Grandidier has, however, recently described the leg-bone of what appears to be another member of the same group from the superficial deposits of Madagascar, under the name of *Bradytherium madagascariense*. Assuming, as seems probable, that these gigantic edentates originated in the southern hemisphere, the present specimen, if its affinities be rightly determined, affords evidence of a former land connection between Madagascar and South America, and thus supports the view that the latter continent was at one time in connection with Africa.

Notices of Books.

"THE STARS: A STUDY OF THE UNIVERSE." By Simon Newcomb. Progressive Science Series. (Murray.) 6s.—We opened this book with pleasurable anticipations; we closed it with something little short of amazement. Prof. Simon Newcomb is a deep thinker, a laborious worker, a most eminent astronomer. But the readers of this book would never divine that it is by such an author. It is superficial, and not worthy of the name it bears on its title page. And yet, in his preface, Prof. Newcomb says that he did not consider this task an easy one; he had "to study whole chapters of observations and researches on some minute branch of the subject, and condense their gist into a few sentences; now to search volumes of periodicals, perhaps in vain, to find who was first in the field, or what result some investigator had reached; now to do justice to the respective works of students of the same subject; now to recast or rewrite passages in the light of some newly published research." We can find hardly any trace of all this minute and deep research in the work. All the information therein contained Prof. Newcomb must surely have known; must have picked up in the ordinary course of his astronomical duties; must have breathed in almost with the air of his ordinary astronomical life. When any investigation begins to get interesting we are blocked by the stereotyped phrase, "the reasoning is too abstruse and the results too mathematical to be easily presented in the present work." But this elision of all reasoning that may not be plain to the dullest, sometimes renders Prof. Newcomb's own meaning obscure. For instance, in giving Myers' working out of the system of the double star Beta Lyrae, he says, "Beta Lyrae consists of two bodies, gaseous in their nature, which revolve round each other so near together as to be almost in contact. They are of unequal size. Both are self-luminous . . . . . This theory receives additional confirmation from the fact shown by the spectroscope, that these stars are either wholly gaseous or at least have self-luminous atmospheres." On the surface it would appear as if Prof. Newcomb imagined that the stars were in general solid or liquid bodies, or that they shone by reflected light. The sense of disappointment which the book inevitably produces is, however, almost entirely due to its falling so much below the high reputation of its author. Had it been written by someone whose acquaintance with the science was merely literary, there would have been much in it to praise. And even as it is, the last three chapters must be excepted from the strictures pronounced on the book as a whole, as Prof. Newcomb has taken in them a much more serious view of his task, and they are consequently on a higher level than the greater part of the work.

"HISTORY OF GEOLOGY AND PALÆONTOLOGY TO THE END OF THE NINETEENTH CENTURY." By Karl Alfred von Zittel, Professor of Geology and Palæontology in the University of Munich. Translated by Maria M. Ogilvie-Gordon, D.SC., PH.D. (Walter Scott.) 6s.—In 1899 Prof. von Zittel's "Geschichte der Geologie und Paläontologie" appeared as a volume of 870 pages, closely printed in the now archaic German type. Mrs. Gordon's translation, under the auspices of the Contemporary Scientific Series, puts in the hands of all readers a record of progress and discovery which is of interest to workers and thinkers far outside the special lines of geology and palæontology. The book has, however, been reduced in bulk, and this has involved the removal of the very valuable lists of works referred to by von Zittel, which conclude each chapter of the original.

A reference to the original is desirable on account of the introduction by the translator of phrases and sentences which undoubtedly modify the work. We are firmly of opinion that such changes should always be made within brackets or in footnotes. What we want to know is how von Zittel, a dispassionate author of singular reserve and judgment, regards this or that movement, or this or that influence, at work in helping on our science. Von Zittel himself seldom, however, allows his own opinions to obtrude themselves; hence the words "feine Beobachtung und logische Scharfe," "von seltener Originalität," or, on the other hand, "von geringer Wichtigkeit," have from him a meaning far above the phrases of ordinary controversy. But this fact makes it especially undesirable to import similar phrases into his "translated" work; and we may regret, from this point of view, even the fine passage on Hutton inserted by Mrs. Ogilvie-Gordon on page 72. The chapter on the Triassic Period suffers especially from changes of this kind; and subtle little adjectives creep in, and even accusations of carelessness, tending to the discredit of one of the most dignified members of the Viennese school, in contrast with his brethren in Bavaria.

The author himself is partly responsible for some points which may be rectified in the next edition. In so comprehensive a treatise the titles of books may occasionally go astray, as when "Felsarten" is written for "Gesteine," in a reference to Zirkel on page 330, and "Lithographia Würceburgensis" for "Lithographiæ Wirceburgensis specimen primum," on page 18. We have, however, "*Das Flötzgebirge Würtembergs*," "Pennant's *Book of Travel*"—a title that it would be difficult to trace in a library—and other slips, some of which are due to the unfortunate practice adopted by the translator, and occasionally even by von Zittel, of giving the titles of memoirs in a language other than that used by their authors. When some of these titles are translated from English into German and back into English, the possibility of error is apparent. As an example, we suspect that Carpenter's "Introduction to the Study of the Foraminifera" is meant to be referred to on page 383; the title as given is a modified translation of a general phrase written by von Zittel.

The translator's intimate knowledge of German, and her own wide range of geological work, have equipped her well for a task involving very considerable labour. We hence find amazingly few slips in nomenclature—the "phosphorus beds," on p. 420, should be "phosphorite" or "phosphate" beds, and on p. 73 "carbonic acid" is said to have become "converted under this pressure into a granular substance resembling marble." On p. 243, "diatoms" are substituted incorrectly for the "Algen" of the original; the organisms somewhat vaguely discussed by Weed are filamentous forms.

Where notable departures from the original have been occasionally made, we might, perhaps, have expected the introduction of new matter in the form of notes or addenda here and there. On p. 424 or 541, a reference to Dubois and *Pithecanthropus* would seem natural in the year 1901; it is high time for the geologist, and even for our cautious Geheimrat, to accept responsibility for dealing in a systematic way with the precursors of the human race. On p. 337, again, the earnest persistence of English petrographers, notably Judd, in urging that geological age was practically valueless in any scheme of classifying igneous rocks, is not done justice to when we are told that "Rosenbusch (!) removed the final judgment of petrography from the laboratory to the field." The phrase is almost as emphatic in the original; and German writers, at any rate, may easily be excused for believing that the introduction of the microscope threatened the "natural history" aspect of petrography in other countries as completely as in their own. Von Zittel's review, however, of the relations between Prof. Rosenbusch and MM. Fouqué and Lévy is one of the best illustrations of his extraordinary grasp of the range of geological research.

Another small correction which it seems extremely difficult to introduce, even into English treatises, is the substitution of the English chemist's name, Sonstadt, for Thoulet (p. 333) as the first who used the solution of mercury and potassium iodides in refined specific-gravity determinations. On p. 334, "Bréon" is a slip, in the original, for "Brauns," who proposed the use of methylene iodide. In conclusion, let us be grateful for a handy book which has justly taken the place of all previous attempts to deal with the history of geology.

"Elements of Botany." By W. J. Browne, M.A. Fifth edition. Illustrated. (Heywood.) 2s. 6d.—This new edition of Mr. Browne's useful little primer is considerably enlarged and abundantly illustrated. The greater portion of the book is occupied with descriptive detail. This is well done, and the numerous illustrations which are provided are helpful. We fancy the book is intended for the use of students entering for the examinations of the Science and Art Department or other bodies. Were it not so the beginner might find the subject matter more attractive and more living if there were less structural botany and more natural history of plants. We find in the book very little relating to life-histories, or to the relation of plants to their environment. The interesting subject of the dispersal of fruits and seeds is dismissed in a page and a half, while the history and geography of plants on this earth are not touched on at all. Botanical examination papers do not usually err on the side of undue attention to this side of the subject; yet in the Science and Art and London University papers, given at the end of the book, we find elementary questions relative to the dispersal of seeds and the characters of maritime plants that could hardly be answered from this book. Mr. Browne's primer is, however, eminently adapted for its purpose; but we would hope that, in the course of time, elementary examination papers on the subject may deal more with the botany which the child may learn out of doors and by its own observation.

"The Process Year-Book, 1901: An Illustrated Review of the Graphic Arts." Edited by W. Gamble. (Penrose & Co.)—The Annuals, of which this is the seventh, published by Messrs. Penrose, evidence the increasing attention given by the public to book-illustration by the sustained high quality of their reproductions. The various beautifully finished blocks printed in one tint or in three colours, which adorn this Annual, cannot fail to afford great pleasure as examples of British workmanship. Numerous articles are given, explaining processes and detailing methods by which present results have been reached. These, though very brief, are written by authorities on the several subjects, and adequately fulfil the purpose of an excellent Year-book.

"Nautical Astronomy." By J. H. Colvin, B.A. (Spon.) 2s. 6d. net.—A useful little book, covering the entire course required in the Board of Trade Examination for Extra Master, as well as for the ordinary examinations of that body. It will be found of service also to the navigating officer as a book of reference.

"A Record of the Progress of the Zoological Society of London during the Nineteenth Century." Edited by the Secretary.—More than half this book is devoted to a list of names of Fellows of the Society. The remainder forms a brief, too brief we consider, but very interesting yearly record of the progress of the society. It deals chiefly with important exhibits at the gardens, erection of new buildings, births at the gardens, and a few notes on the society's publications.

BOOKS RECEIVED.

Chemistry for Photographers. By Charles F. Townsend, F.C.S., F.R.P.S. (Dawbarn & Ward.) Third Edition. Illustrated. 1s. net.

Solar Constant. By Frank W. Very. (Washington: Weather Bureau.)

On the Relation of Phyllotaxis to Mechanical Laws. Part II. *Asymmetry and Symmetry.* By A. H. Church. (Williams & Norgate.) 5s.

Certain Personal Matters. By H. G. Wells. (Fisher Unwin.)

Farm and Home Year Book. Third Edition. Illustrated. 1s.

Exemplary Novels. Vol. I. By Miguel de Cervantes. Edited by H. Buxton Forman. (Gowans & Gray.) 1s. net.

Text-Book of Geology. By Albert Perry Brigham, A.M., F.G.S.A. (Hirschfeld.) 6s. net.

The Discovery of the Future. By H. G. Wells. (Fisher Unwin.) 2s.

The Procession. February. (Los Angeles, Cal.: Heald.) 10 cts.

Report of Weather, Sevenoaks, 1901. (W. W. Wagstaffe.)

The Aspirate. By the Rev. Geoffry Hill. (Fisher Unwin.) 3s 6d. net.

Geology. By Sir Archibald Geikie, F.R.S., &c. (Macmillan.) Illustrated. 5s.

Poultry Management on a Farm. By Walter Palmer, M.P. (Constable.) Illustrated. 1s.

Jamaica. (Geo. Philip & Son.) 6d. net.

Selection of Subject in Pictorial Photography. By W. E. Tindall, R.B.A. (Iliffe.) Illustrated. 3s. 6d. net.

Journal of the Society of Comparative Legislation. December, 1901. (Murray.) 5s. net.

Plant Structures. By John M. Coulter, A.M., PH.D. (Hirschfeld.) 6s. net.

Plant Relations. By John M. Coulter, A.M., PH.D. (Hirschfeld.) 6s. net.

C. G. S. System of Units. By J. D. Everett, M.A., D.C.L., F.R.S., F.R.S.E. (Macmillan.) 5s.

Nature's Mysteries. By A. P. Sinnett. (Theosophical Publishing Society.) 2s. net.

Practical Retouching. By Drinkwater Butt, F.R.P.S. (Iliffe.) 1s. net.

English Public Opinion after the Restoration. By Gerald Berkeley Hertz, B.A. (Fisher Unwin.) 3s. 6d. net.

Practical Exercises in Magnetism and Electricity. By H. E. Hadley, B.SC. (LOND.). (Macmillan.) 2s. 6d.

Early Work in Photography. By W. Ethelbert Henry, C.E. (Dawbarn & Ward.) Illustrated 1s. net.

Atlas of Practical Elementary Zootomy. By G. B. Howes, LL.D., F.R.S. With Preface by the late Right Hon. Prof. T. H. Huxley, P.C., F.R.S. (Macmillan.) 10s. 6d. net.

British Tyroglyphidæ. By Albert D. Michael, F.L.S., F.Z.S., F.R.M.S. (Ray Society.) Illustrated.

WING-LINKS.

By E. A. Butler, B.A., B.SC.

In the present paper I propose to deal with the different devices that are to be found in the structure of four-winged insects, for linking together the fore and hind wing on the same side during flight, so as to produce an increase of power in the simultaneous use of the two pairs of wings. The extensive order Diptera, therefore, consisting, as it does, wholly of flies which have only one pair of wings fully developed, will be outside our present purview. And so equally will the Coleoptera, or beetles, for, although at first sight they appear to have two pairs of wing-like appendages, yet, as only one of these is used for the actual accomplishment of flight, the insects are, for all practical purposes, dipterous. Putting these two great orders on one side, therefore, we find that the rest, with the exception of a few small groups which are apterous, are all four-winged, and use both pairs in flight. Out of this enormous assemblage of four-winged creatures, however, our attention will be mainly concentrated on two orders, the Hymenoptera and the Lepidoptera, for, with few exceptions, it is in these two alone that we find any special structures such as are indicated above.

But, before considering these, there is one group of insects that, for an opposite reason, merits notice because of the entire independence with which the wings work. These are the dragon-flies, the wings of which differ in several important characters from those of most other insects. The power of flight in dragon-flies varies very much. While the larger kinds are extremely powerful fliers, and when "hawking" for their prey can go sailing along at a high rate of speed, the smaller and more fragile species have to content themselves with a comparatively weak sort of flutter. In all the species, however, the fore and hind wing on each side are independent of each other; they do not touch, and though they move simultaneously, there is a certain space left between their edges through which the air can pass as the wings move up and down. Again, throughout the Insecta, the secondary, or hind-wings, are generally of a more delicate texture than the primaries, and often smaller in area, but, if not actually smaller, they yet have to be folded up and tucked away under the primaries when the insect assumes the position of rest. In all these points dragon-flies differ from most other insects. The two pairs of wings are approximately of the same size, and of similar texture, and in the attitude of rest the secondaries are not folded and packed away beneath the primaries. A large dragon-fly when hunting its prey on the wing must, of course, be able, if it is to be a successful hunter, rapidly to alter its course and adapt itself to the sudden movements of its quarry. These insects are, in fact, adepts at "dodging," and however fast they may be flying, can instantly wheel at a sharp angle, or even make a complete *volte face*. It can hardly be doubted that the independence of the wings is an important factor in these movements, so that, while a certain amount of power is lost to the stroke by the fact that the wings are not linked together, yet this is compensated for by the ability to wheel suddenly, which is brought about by the absence of such union.

In this country we have only a few other insects with wings constructed like those of dragon-flies; the chief of these are the lovely lace-wing flies, which are amongst the most delicate and fairy-like creatures we possess. But as they have only a very feeble power of flight, they need not concern us further on the present occasion.

We pass now to those insects that possess wing-links of some kind or other. Amongst these the Hymenoptera take the first place. The order contains bees, wasps, ants, sawflies, and that host of parasitic insects known as ichneumon flies. These creatures have two pairs of membranous wings, the anterior of which are much larger than the posterior. Each wing, whether primary or secondary, is by itself long and narrow, and in proportion to the size of the body, offers but a small surface to the action of the air, and hence would not have much sustaining power. But the anterior edge of the hind-wing has nearly the same outline as the posterior edge of the fore-wing, so that, when in use, the two fit pretty accurately together, one behind the other. This alone, however, would not be of much good, as the two wings would be easily liable to be separated in flight, and thus break the force of the stroke. But there is a beautiful arrangement which keeps them in position relatively to one another, and thus enables them to offer to the resistance of the air what is practically an unbroken surface equal to their combined areas.

The wings of a hornet, or failing these, of a humble bee, or wasp, will show this arrangement admirably. For a certain distance, beginning rather more than half-way along the anterior edge of the hind-wing, there is a series of hooklets bent obliquely outwards, upwards, and backwards. Fig. 1 shows the arrangement of these in a

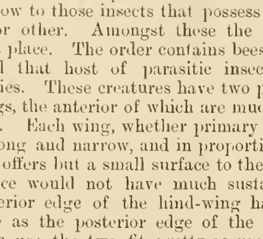


Fig. 1.—A, Wings of Hornet. *a*, Fold on Fore-wing. *b*, Hooks on Hind-wing. Magnified two diameters. B, Portion of Hooked Margin. Much more highly magnified.

hornet's wing. The number of hooklets varies with the insect; for example, the hornet has 29, and the hive bee about 23, humble bees have from 19 to 26, according to species and sex, and so on. In general the number appears to range between one and two dozen, but the ichneumon flies have fewer, while the giant Sirex, or tailed wasp, the largest hymenopterous insect we possess, has upwards of 50.

Along the hinder edge of the fore-wings, in the part immediately opposite the hooks, the membrane is strengthened and bent under, forming a sort of trough or gutter. When the wings are expanded, the hooklets of the hind-wing hang over the edge of this trough, and thus the two wings are firmly linked together, so that any movement of the one drags the other with it. And this is advantageous in more ways than one. For in the Hymenoptera, as in insects generally, the chief muscles of flight are those attached to the fore-wings; they are far more bulky and powerful than those belonging to the other pair, hence the linkage compensates for the lack of muscular force in the hind-wings, and enables them to partake of the superior strength of the primaries. Further, it will be seen that the arrangement by which the hooks of the hind-wings lay hold of a fold *above* them and *under* the fore-wings, brings about a still closer union between the wings during the down stroke when the greatest power is required for propelling the insect, whereas if they were attached in the opposite way, there would be a greater tendency for them to loosen their grip, and so defeat their purpose.

The hooks are simply modified hairs, and the hornet shows a gradual change of form in them as we pass along the series, from the completely hooked and strongly gripping clasper at one end, to the scarcely bent but stout hair-like objects at the other, which have obviously very little clasping power left. The rest of the wing-margin at both ends of the series is bordered by simple hairs of the ordinary type. Of course these hooks, under the most favourable circumstances, are extremely small, and need the use of a microscope for their examination. But their power is easily demonstrated in a fresh specimen of the insect; for if, by grasping the fore-wing between thumb and finger or with forceps, we move it in any direction, we find that the hind-wing of the same side accompanies it in all its movements.

In the Lepidoptera, the order which contains the butterflies and moths, the arrangement is of quite a different character. In the butterflies, there is no special apparatus to link the wings together, but their united action in the down stroke is assured by the fact that the fore-wing at its inner edge laps considerably over the hind one. The depression of the one, therefore, carries the other with it without difficulty. In moths there are two different plans for bringing about the same result. Suppose we take such a creature as the Ghost Moth (*Hepialus humuli*). This is a very common insect, and is remarkable as having a completely different coloration in the two sexes; the male is entirely white above and smoky beneath, while the female is of a tawny yellow with reddish markings on the fore-wings. Near the base of the fore-wing at its inner edge in either sex, a small projecting lobe is seen, of a membranous nature, but stiff, and furnished with a fringe of long hair (Fig. 2). The points of attachment of the two wings to the thorax in this insect and its allies, are so situated as to leave a small gap at the base of the wings when they are spread for flight. This allows the above-mentioned lobe to get beneath the margin of the hind-wing, while the rest of the fore-wing, as usual, overlaps; thus the wing is held, as it were, in a clip, and the united action of the two is aided to some extent, though not very efficiently.

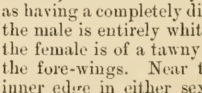


Fig. 2.—Right Fore-wing of Ghost Moth. *a*, Jugum.

This kind of link is found in two families of moths only, viz., that of the Swifts, to which the Ghost Moth belongs, and a family of extremely minute moths which rejoice in the rather cumbrous name of *Micropterygidæ*. As these minute insects are known only to the learned in such matters, they have no popular name, and we must perforce use their long-winded family title. While the Swifts are for the most part soberly coloured, the *Micropterygidæ* are some of the most brilliant insects we possess, and if only they were magnified to the dimensions of the Swifts, they would be the admired of all observers. The ground colour of the fore-wings is usually a deep shining golden bronze, and this is crossed in some cases with bars of polished purple or silver. Many of them are common enough in early summer in flowers or on the leaves of young trees, but they are so small that they usually escape notice, and a lens is necessary to make out fully their beauties. Both these groups of insects possess this clasping lobe, and though at one time placed far apart from one another in systematic classification, they are now often associated together because of this and other peculiarities, and many entomologists believe that they represent the most ancient and primitive type of Lepidoptera to be found throughout the world.

To observe the other method of linkage that prevails in the Lepidoptera, almost any kind of moth may be used. We might, for example, take such an insect as the Common Yellow Underwing (*Triphæna pronuba*), a moth that is so abundant as to be within the reach of everybody. Suppose we take first of all a male specimen; if we separate one of the hind-wings we see proceeding from a point very near its place of articulation, a strong, stout, curved bristle (Fig. 3, *a*), which is delicately grooved throughout its

Fig. 3.—Right Hind-wing of Yellow Underwing. *a*, male; *b*, female.

length, and ends in a finely drawn-out point. This is only half the apparatus, and to find the other part we must go to the fore-wing. Here, attached to the first of the great nervures that radiate over the surface of the wing, just below the anterior boundary, and not far from its base, is what looks like a swelling or excrescence. To see its true

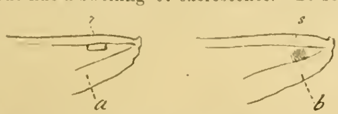


Fig. 4.—Underside of Base of Right Fore-wing of Yellow Underwing. *a*, male; *b*, female; showing Retinaculum, *r*; Tuft of Scales, *s*. Magnified 2 diameters.

form, it will be necessary to remove the scales with which it is thickly covered; a little brushing with a camel's hair brush will easily do this, and then it appears as a longitudinal flap or coil of stoutish membrane projecting from the nervure, and with its free end bent under in such a way as to leave a passage between itself and the general surface of the wing (Fig. 4, *a*). If we now examine the moth with its wings in position as if for flight, we see that the bristle of the hind-wing passes through the loop on the fore-wing, like a thread through the eye of a needle, and thus the two wings are linked together (Fig. 5).

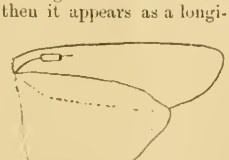


Fig. 5.—Underside of Left Wings of Male Yellow Underwing, showing Spine passing through Retinaculum.

Next let us take a female, and deal with it in the same way. We find now that instead of a single bristle there are three somewhat weaker ones (Fig. 3, *b*), one of which is very fine, and all are bent at a sharper angle than in the male insect. When we examine the fore-wing, we find that the loop-like retinaculum, as it is called, has entirely disappeared, and instead of it we find a bunch of scales pointing in the opposite direction, and springing, not from the nervure before-mentioned, but from the next one farther down the wing (Fig. 4, *b*). Examining the wings in position, we find that the cluster of bristles on the hind-wing is thrust through and entangled in this bunch of scales, and thus the two wings are held together to some extent, but of course not so effectually as in the male insect.

There is a slight variation from this type in the day-flying Burnet moths. These brilliant insects, with their glossy greenish-black fore-wings relieved by crimson spots or streaks, and with crimson hind-wings, form some of the prettiest ornaments of our grassy hillsides as they fly from flower to flower in the brightest sunshine. In place of the customary loop on the fore-wing we find them provided with a sort of pocket into which the tip of the bristle is thrust. In the long-winged and swift-flying Hawk-moths, which are for the most part crepuscular in their habits, the linking apparatus reaches its highest development, in accordance with the exceptional vigour and speed of their flight. In the Poplar Hawk-moth, however, which is the most sluggish of the group, the apparatus is quite rudimentary, and this, again, is in accordance with its habit of carrying its hind-wing, when at rest, in such a way that its front margin projects beyond the fore-wings, for this would obviously prevent the bristle, if it were present, from being passed through the loop.

There is another very curious variation in a group of small moths called "Pearls." One of the commonest of these is a long-legged insect generally found amongst nettles; it has glossy yellowish-grey wings, marked with wavy lines, and showing a certain amount of iridescence, whence its common name "Mother of Pearl" (*Botys verticalis*). In this insect and its allies, the male imitates the female in being destitute of the loop, and thrusting its bristle into a tuft of scales.

The difference between the single spine of the male and the group of spines which is characteristic of the female, is more apparent than real. For if the male spine is closely examined under the microscope, it is seen as before-mentioned to be distinctly furrowed, and a transverse section shows that it is made of several spines which have coalesced. Thus both arrangements consist of a group of spines, which in the one case are compacted, and in the other remain distinct.

From this sexual difference one would be inclined to argue that male moths would exhibit a power of flight somewhat superior to that of their partners, and it is certainly true, in some instances at least, that the females are much more sluggish than the males, and when on the wing fly more heavily; but it can hardly be said that this is generally the case in any marked degree, and even if it were so, the greater weight of the body in the female insect might be as effectual a cause of retardation as the less close linkage of the wings. And further, in a few instances, such as the Drinker and Oak Egger moths and their allies, the males of some of which are extraordinarily active, flying with great force and speed even in hot sunshine, the wing-links are altogether absent. In these cases, however, the secondaries, by their great development anteriorly, considerably underlie the primaries, and thus no doubt render the spine and loop arrangement unnecessary, if not indeed, impracticable.

PRESERVING AND MOUNTING ROTIFERA.

By Charles F. Rousselet, *Curator, R.M.S.*

For Note referring to Material, see the Microscopy Column.

There be few observers of pond life who have not felt a keen desire to preserve and keep these small highly-organised sparks of life instead of letting them die and disappear in a few days. For a close study of this group, well preserved type specimens are of the greatest possible assistance and importance, and if such had existed formerly much confusion and inexactitude in their description and classification would have been avoided, particularly in the giving of three or four different names to the same species, which causes so much trouble to the student.

The total absence of type specimens of Rotifers to refer to when required originally led me to attempt to produce them, and it is now over ten years since the first successful experiments at preserving them in a fully extended and natural state were made. My method, although so simple now, took fully three years to work out until the right and most suitable narcotic, fixing agent, and preserving fluid were found. By the use of suitable fixing agents, not only the external shape of Rotifers can be preserved, but also all the internal structure to the minutest anatomical details, such as the striated muscle fibres, nerve threads, vibratile tags or flame cells, sense hairs, cilia, etc., and frequently important details can be more readily observed than in the living animal.

As is well known, no killing agent is sufficiently rapid to prevent the complete retraction of Rotifers, and few other animals can contract into such a shapeless mass when we attempt to kill them by ordinary means, such as poisons, alcohol, heat, etc. It is, therefore, necessary to use first a suitable narcotic, which has been discovered in hydrochlorate of cocaine. As a result of many trials, the best solution for most Rotifers has been found to be the following mixture:—

2 % solution of hydrochlorate of cocaine, 3 parts;
Alcohol (or methylated spirit), 1 part;
Water, 6 parts.

Another narcotic which is also very suitable for Rotifers is a one per cent. watery solution of hydrochloride of eucaine, recommended by Mr. G. T. Harris, for Infusoria and other animals. These narcotics, even so dilute, are not to be used pure, as they would cause the Rotifers to contract at once and not expand again. The principle to be followed throughout is to use the narcotic so weak that the animals will not mind it at first, but continue to expand or swim about freely. After a short time its effect will make itself felt on their nervous system, and then some more of the narcotic may be added, until complete narcotisation is produced, or until the animals can be killed without contracting.

But before the operation of narcotising is begun, it is very necessary to isolate the Rotifers in perfectly clean water. The best way is to pick them up under a dissecting microscope by means of a very finely drawn-out pipette, having a funnel-shaped enlargement at the other end, which is covered with an elastic membrane. This pipette forms a most delicate syphon, by means of which any selected Rotifer can readily be taken up with the least quantity of water, and transferred to another trough or watch-glass full of clean water. This preliminary precaution is necessary, because particles of dirt in the water readily attach themselves to the cilia of dead Rotifers, rendering them unsightly under the microscope. Another advisable precaution is to separate the different species, because most species require a slightly different treatment, and because the small species too readily adhere to the cilia of the large species.

Having then isolated a number of free-swimming Rotifers in a watch-glass half full of perfectly clean water, one drop of one of the above narcotics is added and well mixed. After five or ten minutes, if the animals continue to swim about freely, another drop is added, and so on until the effect of the narcotic becomes visible, and until the motion of the cilia, or the movements of the animals slacken or almost cease, when they are ready for killing. The effect of the narcotic varies very much with different species, some are most sensitive to it, whilst others can stand a considerable quantity for a long time. Some practice and patience are certainly required to find out the right time to kill the different species; no general rule can be given, as the time may vary from 15 minutes to several hours. It is very essential, however, that the Rotifers be still living when the killing fluid is added to prevent post-mortem changes in the tissues which begin at once on the death of the animals. *(To be continued.)*

Conducted by M. I. Cross.

Pond-life Collecting in March.—The same species as those mentioned for February are still to be found and in greater abundance. Some new Infusoria will have made their appearance, such as *Stentor polymorphus*, which will be found covering the rootlets of Duckweed and other submerged plants, *Peridinium tabulatum* and the free-swimming colonies of *Synura uvella*, etc. Then the very minute and beautiful colonies of Collared Monads, *Codosiga umbellata*, and other species of this group may be looked for, attached to the stems of Vorticella trees.

All the Rotifera forming the winter fauna will become very abundant in March, and as the food supply in minute Algae and Infusoria increases, fresh species make their appearance with every rise of temperature. The following additional species may be looked for: *Brachionus angularis; Notholca acuminata, spinifera,* and *labis; Euchlanis oropha; Dinocharis pocillum; Diaschiza lacinulata; Proales decipiens* and *petromyzon; Monostyla cornuta, Diglena forcipata; Rotifer vulgaris.*

Testing Objectives.—To judge decidedly for oneself whether an objective is a good, bad, or indifferent one is a matter that calls for more than ordinary discrimination, and there are but few workers whose judgment as to the merits of any particular lens would be accepted without reservation.

It may almost be said that the microscopist who is capable of judging lenses is born and not made, for while some can almost by intuition give an opinion which will ultimately prove correct at almost the first sight of a favourite object through the objective, others who have had perhaps excellent opportunities of acquiring skill are unable to arrive at a reliable decision. Practice, on proper lines, will however greatly assist in estimating the quality of lenses, and it will be well to enquire what the elements of a good objective are and what tests can be applied to determine without doubt whether or no it is accurately constructed and of good performance.

The qualities of an objective depend particularly on centreing, corrections for chromatic and spherical aberration, and accuracy of manufacture. Beyond these, numerical aperture and initial magnifying power require consideration.

We will assume for our purpose that the objective is made on a good formula and is constructed on rational modern principles such as are adopted by all up-to-date opticians, and proceed to consider the tests that may be applied. For the majority of optical instruments, standards are set, and if the specimen under examination conforms to that standard or is equal to it, it is considered satisfactory, but the microscope objective has qualities under so many phases, each series of lenses having their own peculiar characteristics, that it is almost impossible to have a standard test for all the qualities, still it would be a most advantageous and desirable consummation if some centre could be arranged where undeniable unprejudiced reports could be obtained concerning objectives. It might be that an objective that was admirably corrected for spherical aberration, well centred and possessing a proper ratio of aperture to magnification would be high in colour when the colour tests were applied; this would not necessarily be a bad or inferior lens, and might be superior to an apochromatic in which the colour correction was perfect, while the spherical aberration was not so well controlled. Tests that are applied to objectives should be as far as possible mechanical ones, that is, such as will admit of but slight error of judgment, but this is only partially possible. For instance, the numerical aperture and initial magnifying power can be determined, the former by means of the Apertometer, and the latter by the regular rules laid down in the text-books. Yet in so simple a proceeding as measuring the aperture, there will frequently be a considerable variation between the results obtained by separate individuals: even this requires not merely care and skill, but a large amount of experience. The only way is to take readings several times and to strike an average for the result. It will, probably, be found that if four readings be taken, the Apertometer pointers will be at a different position on each occasion.

After many years of experience in examining and criticising lenses, I have found nothing so thoroughly satisfactory for getting at the real accuracy of an objective as the "Abbe Test Plate." Its merits are hardly recognised in the manner they should be probably for the reason that microscopists generally are quite content to take the quality of their objectives for granted and to refrain from splitting hairs over fine details, but no man can be a master of his instrument without being fully conversant with the possibilities or drawbacks which his lenses may possess. *(To be continued.)*

New Microscopes.—Messrs. R. & J. Beck have sent a price-list and particulars of the "Imperial" Microscope, a new instrument designed by them for critical work.

It is made in four different models and supplied with both horseshoe and tripod bases. The most complete instrument of the series on tripod foot has special claims to consideration, for it is provided with every convenience that the modern worker with objectives and condenser of high aperture could desire.

All the instruments of the series are fitted with the new two speed fine adjustment to which reference was made in these columns in the January number.

I am just a little doubtful of the expediency of fitting a mechanical stage with the controlling milled heads perpendicular to its surface. In turning them, pressure will be exerted downwards and there would be a natural tendency for the object to go out of focus.

By adopting this method of construction, however, the added convenience of complete rotation to the stage is gained and the plates of the mechanical fittings do not come in contact with the substage condenser, a very desirable consummation.

Foraminiferous Material.—The number of applicants for this so far exceeded expectations, that the supply to each one had to be limited considerably. Several readers omitted to send a stamped directed label; a small quantity may yet be had by such on compliance with this condition.

Mounting and Preparing Rotifers.—For the benefit of those readers who may wish to experiment on the lines recommended by Mr. Rousselet, and who may have difficulty in securing the specimens, it may be worth while to mention that both Mr. Bolton, 25, Balsall Heath Road, Birmingham, and Mr. Pearsall, Headmaster, Senior Mixed Board School, Dalton-in-Furness, supply Rotifera in tubes: the former at 1s., and the latter at 1s. 3d. per tube including postage.

The Rev. E. J. Holloway, of Clehonger Vicarage, Hereford, also kindly offers to supply Rotifer material, particularly *philodina*, to readers, in order to further the work of the "practical" scheme. It would be courteous if such as avail themselves of this offer would send a tube with an addressed label bearing stamps for the cost of the return postage.

A lady reader also kindly offers to supply a limited quantity of Mycetozoa.

Consultants.—In response to the invitation for assistance in the January number, one gentleman has kindly consented to name Diatoms and another to identify micro fungi infesting plants, etc.; if any who feel able to assist in other departments will communicate with me, I shall be glad.

NOTES AND QUERIES.

O. Evans.—The material concerning which you require information has been kindly examined by Mr. A. Earland, together with your drawing, and the following is his report:—"True coccoliths, *i.e.*, the calcareous surface plates of the microscopic alga Coccosphaera have been found in the chalk and in other fossil deposits, but they are of rare occurrence."

The term "coccolith" is, however, very loosely used by geologists for the description of almost any small plate-like perforated body, approximating to the true coccoliths in shape and size.

Mr. Oswald Evans' figures 1—8 and 10, with one possible exception (fig. 9), all belong to well-known forms of these "spurious" coccoliths, which are of frequent occurrence in many fossil deposits. Their nature and origin are quite unknown. One thing only is certain, they have no connection with the true coccoliths, which have an altogether different structure. Presumably they are the remains of some organism or organisms quite extinct and unknown.

The essential feature of a true coccolith is its "double structure." Each coccolith consists of two curved plates (oval in *Coccosphaera pelagica* Wallich, and round in *C. leptopora* Murray and Blackman) united by a central column, which is pierced by a median pore. A true coccolith therefore bears some resemblance to a shirt stud with a hole pierced right through the middle.

Figure 9, though it does not show this double structure, bears some resemblance to a true coccolith (of *C. leptopora*), and might prove to be one. Figures 11 and 12 are rather curious; 11 seems to be a stellate microschlere from a sponge; 12 might be of Radiolarian origin; 19, 20, 21, are certainly sponge spicules, and 22 is probably a sponge sterraster with adventitious perforations.

Rhabdolith is used by geologists in a very wide sense also. Of the Figures 13—18, only two, viz., 15 and 16, *could* be true rhabdoliths, and the detail of the drawing is not sufficient to determine this with certainty.

Figs. 13, 14, 17 and 18 are almost certainly of sponge origin, more or less eroded.

J. Searle, Oporto.—This correspondent has expressed his willingness to supply material towards the success of the practical scheme. He suggests that living in Portugal, there might be some object or series of objects which would be interesting to readers. Also he would be glad to exchange material, etc., with other microscopists. If any readers would like to communicate with this gentleman, I shall be pleased to re-address their envelopes.

F. R. C. S.—Any of the binocular microscopes made by the opticians who advertise in this journal would give you satisfaction. You will find that it is well not to have the binocular body less than 8 ins. long; shorter ones have been made, but they are not nearly so satisfactory. The Wenham, which is the usual kind of binocular, will prove most serviceable; it can always be rendered monocular by sliding the prism out of position, for which provision is made; the light then only passes up the monocular tube. Binocular eye-pieces have never proved really comfortable in the tests that I have made.

J. H. G. inquires if any method is known of mounting Cladocera so as to preserve the transparency. He also suggests that some notes on the preparation and mounting of Entomostraca might prove interesting. Can any readers give information or assist in these matters?

G. Fisk.—Seeing that you have a ⅛" objective, it is absolutely necessary for you to use an illuminating apparatus, you cannot secure satisfactory results without it. It its absence you are not working your objectives to anything like their full capacity, and you will be surprised at the improvement you will obtain when the condenser is added.

T. Peters.—An article on Microtomes as suggested by you will appear in a month or two.

A. E. F.—You will find the information you require in an article on "The Specific Gravities of Saturated Solutions of Stains," given in detail in the "Knowledge Diary and Scientific Handbook for 1902." This is published at "Knowledge" Office and contains a variety of useful information in addition to the diary itself.

C. S. Purcell.—Any of the methods in use for the demonstration of flagella will show those of the *B. Subtilis*. Perhaps the best and easiest is the Pitfield modified by Muir (*vide* page 116 of the last edition, Muir & Ritchie's Manual of Bacteriology).

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.

Next Return of Halley's Comet.—As we draw nearer to the time of perihelion passage in 1910, the interest in this object will continue to increase. There is no other comet which has so many important historical associations and whose apparitions can be traced from so remote a period. It was visible in the year of the Norman Conquest, and its first well-recorded appearance through more than nineteen centuries to nearly twelve years before the Christian era. This comet is only perceptible once within the allotted term of human existence, since it revisits the sun every 77 years, and there are very few persons who have lived in the particular period and to the great age necessary to afford them the privilege of viewing the comet at two returns. We may discern that small "Mercury of comets," called after the illustrious Encke, again and again, for its solar visits are repeated at short intervals of 3⅓ years, but the comet of Halley ordinarily furnishes but one spectacle at most during a lifetime. Since the year 12 b.c. the latter comet has nearly accomplished 25 revolutions, and Mr. J. R. Hind gave some interesting details of its previous apparitions in Vol. X. of the *Monthly Notices* (January, 1850). Its period varies, owing to planetary perturbation, between 74½ and 79½ years, and the revolution now being performed will be one of the shortest if not the shortest known in the history of the comet, for the last perihelion passage occurred in 1835 (November 15th), while the next is predicted for 1901 (May 23), the interval being equivalent to 74 years and 189 days. Dr. D. Smart has furnished some useful particulars in reference to the next return of the comet (*Journal of the British Astronomical Association*, Vol. XII., p. 134-6), and on the assumption that the perihelion will be reached on 1910, May 23rd, has computed an approximate ephemeris, from which are extracted the following positions:—

Halley's Comet, 1910.

Date.	R.A. h.	m.	s.		Dec. °	′	Distance in Millions of Miles.	Apparent Brightness.
Jan. 7 ...	2	29	28	+	12	42	167	·055
Feb. 8 ...	1	36	24	+	10	57	195	·060
Mar. 12 ...	1	17	40	+	11	33	214	·089
April 29 ...	1	5	20	+	14	59	158	·402
May 15 ...	1	2	40	+	17	38	112	1·30
„ 31 ...	1	23	20	+	30	25	47	7·25
June 16 ...	8	29	24	+	37	28	24	21·00
July 2 ...	11	13	20	+	3	9	74	1·50
„ 18 ...	11	38	8	−	2	37	130	·33
Aug. 3 ...	11	49	44	−	5	32	177	·12

In December, 1909, the comet will be placed in the region of the Hyades and thereafter traverses Aries and Pisces. There is a meteoric shower connected with it and this should be looked for before sunrise during the first week in May. The meteors are directed from a radiant near η Aquari, which does not rise in the latitude of Greenwich until nearly 2 a.m. on May 4th.

The Leonids of 1901.—From a number of accounts received from American observers, it seems that a moderately rich display of these meteors was seen. For several hours preceding sunrise on November 15th the rate of apparition was three or four per minute for one observer, while during the period of greatest frequency there were about twice that number. At several of the stations the maximum appears to have occurred at about 11.30 a.m. G.M.T., or four hours after sunrise in England, and this sufficiently explains how it was that the display proved a meagre one as observed in this country. There were about ten times more Leonids seen in America than in England, and it is certain that the earth encountered the denser part of the stream at a time when it could only be observed at places far west from Greenwich. At some of the American stations meteors appeared to be increasingly plentiful in the morning twilight of November 15th, and it seems possible that the real maximum may have occurred even later than the time given above, in which case it could have been witnessed from the Pacific Ocean, but we have no description of it from voyagers in this region. The fact that the shower showed a marked increase in strength as compared with the feeble exhibitions of the few previous years, encourages the hope that a further revival may occur in November next. The parent comet passed through perihelion in the spring of 1899, but the meteors appear to be plentifully clustered along a considerable section of the orbit in rear of the comet. There were showers in 902, 1002, 1202 and 1602, and observers will therefore do well to make observations in the coming November, though the full moon will offer a serious hindrance.

Relative Heights of Perseids and Leonids.—The real paths of a large number of meteors have been compute l in past years, and especially at those particular periods marked by the occurrence of special displays like the Perseids and Leonids. Our accumulated records are becoming very extensive of the former shower, occurring as it does at a genial season when the skies are often clear, and every year presenting a moderately rich display of long duration. The November Leonids are confined to a more limited interval and are often obliterated by clouds; in some years the display is so feeble that it passes unrecorded. From a comparison of the real paths of Perseids and Leonids it appears certain that the former are rather lower in the atmosphere than the latter, though we have scarcely secured a sufficiently large number of Leonids to institute a fair comparison. The following are the resulting heights, &c., of a number of Perseids and Leonids doubly observed in England during the last fifteen years, and computed by the writer:—

	Height at beginning. Miles.	Height at ending. Miles.	Length of path. Miles.	Velocity per second. Miles.
Perseids	80·3	54·0	42·5	42·2
Number of meteors ...	40	40	39	19
Leonids	84·1	55·9	45·1	49·8
Number of meteors ...	17	17	17	9

The observed velocities of 42·2 and 49·8 miles per second exceed the theoretical velocities (38 and 44 miles), but the discordance may well be induced by errors in the estimate l durations of flight.

THE FACE OF THE SKY FOR MARCH.

By W. Shackleton, f.r.a.s.

The Sun.—On the 1st the sun rises at 6.50 a.m., and sets at 5.37 p.m. On the 31st he rises at 5.42 a.m., and sets at 6.28 p.m.

The Vernal Equinox occurs on the 21st, when the sun enters Aries, and Spring commences at 1 p.m. The disc of the sun promises little of interest for spot observations.

The Zodiacal Light may be looked for in the west for some two or three hours after sunset.

The Moon:—

	Phases.	h. m.
Mar. 2	☾ Last Quarter	10 39 a.m.
„ 10	● New Moon	2 50 a.m.
„ 16	☽ First Quarter	10 13 p.m.
„ 24	○ Full Moon	3 21 a.m.

The following are the more interesting occultations visible at Greenwich:—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point. °	Disappearance. Angle from Vertex. °	Reappearance. Mean Time.	Reappearance. Angle from N. Point. °	Reappearance. Angle from Vertex. °	Moon's Age. d. h.
Mar. 17	26 Geminorum	5·1	9 19 p.m.	136	104	10 16 p.m.	247	209	7 19
„ 18	68 Geminorum	5·0	5 48 p.m.	170	197	6 14 p.m.	211	234	8 15
„ 20	ω Leonis	5·6	8 27 p.m.	106	120	9 45 p.m.	299	297	10 18
„ 22	p^5 Leonis	5·5	11 19 p.m.	148	146	12 24 a.m.	265	251	12 21
„ 29	ν Scorpii	4·5	1 41 a.m.	119	138	3 0 a.m.	265	272	19 0

THE PLANETS.—Mercury is a morning star, having its greatest westerly elongation of 27° 41′ on the 17th, when it rises about three-quarters of an hour before the sun.

Venus is also a morning star situated in Aquarius. She is at greatest brilliancy on the 21st, on which date she rises about an hour and three-quarters in advance of the sun.

Mars is unobservable, being in conjunction with the sun on the 30th at 1 A.M.

Jupiter and Saturn are both morning stars, the former in Capricornus, the latter in Sagittarius, but as they only rise about two hours before the sun, they are not well suited for observation.

Uranus is near the position indicated last month, about 1° north of 44 Ophiuchi. He is in quadrature on the 12th, and stationary on the 27th, rising on the latter date about quarter past one A.M. The great southerly declination of over 23° makes the planet somewhat unsuitable for observing purposes.

Neptune is the only planet that can be observed in the evening. He crosses the meridian shortly after 7 P.M. at the beginning of the month. He is making a short looped path in Gemini on the confines of Auriga, Taurus and Orion; this is shown by the diagram given last month. The planet can be readily found from the triangle of stars which has a double star for one corner almost 1° south of 1 Geminorum, and it is a little brighter than either of the star pair referred to. The planet can also be picked out by observations some few days apart, but this is becoming more difficult since the planet is at the stationary point on the 10th, after which the motion is again easterly.

THE STARS.—About the middle of the month, at 9 P.M., the position of the principal constellations will be as follows:—

ZENITH .	No bright constellations in the zenith.
SOUTH .	Cancer and Hydra on the meridian; Gemini high up, *Procyon* and *Sirius*, all a little to the west. Orion is to the south-west, and Leo (*Regulus*) to the south-east high up.
WEST .	Taurus, Aries nearly setting, Auriga (*Capella*) high up. To the north-west Perseus, also Andromeda low down.
EAST .	Virgo (*Spica* rising), Bootes (*Arcturus*). To the north-east Ursa Major high up, Corona, Hercules and *Vega* low down.
NORTH .	*Polaris*; to the right, Ursa Minor, Draco; below, Cygnus, Cepheus; to the left, Cassiopeia.

Minima of Algol will occur on the 10th at 1.26 A.M., on the 12th at 10.14 P.M., and on the 15th at 7.3 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.

(P. H. Williams.)

No. 1.

1. R to Kt8, and mates next move.

No. 2.

Key-move.—1. B to B2.

If 1. . . . K × P,	2. B to B5ch etc.
1. . . . K to B3,	2. B to K4ch, etc.
1. . . . Kt moves,	2. B to Kt3ch, etc.

[The "reprinted problem" last month should, of course, have been described as a four-move, not a three-move problem.]

CORRECT SOLUTIONS of both problems received from G. A. Forde (Captain), C. D. Brown, H. S. Brandreth, W. de P. Crousaz, S. G. Luckcock, G. Woodcock, W. Nash, G. W. Middleton, H. H. S. (Teddington), F. Dennis, C. Johnston, Sekots, H. Le Jeune, H. Boyes, Alpha, C. R. Beechey, A. C. Challenger, W. J. Allen.

Of No. 2 only, from H. Myers.

H. Myers.—After 1. R to B3 Black plays Kt to Kt4 and there is no mate.

G. B. Davies.—In No. 1 you have overlooked that the White Knight at B4 is "pinned" by the Black Bishop. In No. 2, after 1. P to K7, Kt to Q6 or K7, White must give check, as the Knight threatens to do the same.

W. Jay.—Much regret to hear your news, and trust that you will be able to compete when the new Solution Tourney begins. At what date would you prefer your year's subscription to KNOWLEDGE to commence.

Whitchurch.—Your solution of No. 1 (January) was received too late to acknowledge. After 1. Kt to K2ch, Kt × B, 2. R to R5ch is not mate, as the Kt can interpose.

W. J. Allen.—Yes, "three" was a misprint for "four." Your suggested solution by 1. Kt to Kt6 was fully dealt with last month. Black saves himself by obtaining a stalemate position, playing 1. . . . P to R7, and 2. . . . P to R8 (becoming a Bishop), while White has to block the King's Pawn by 3. Kt to K5. This device constitutes the main idea of the problem, which is otherwise worthless, except for the key.

TOURNEY PROBLEMS RECEIVED.—"Satis," "Nemo saltat sobrius."

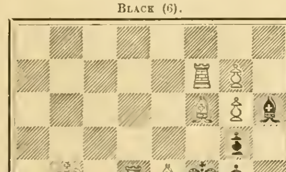
PROBLEMS.

No. 1.

By A. F. Mackenzie.

[First prize in *Brighton Society* Tourney.]

BLACK (6).



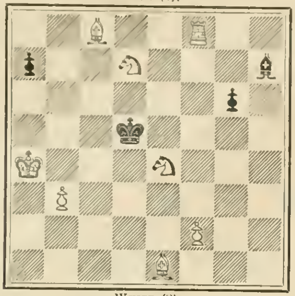
WHITE (11).

White mates in two moves.

No. 2.

By E. G. B. Barlow.

Black (4).



White (8).

White mates in three moves.

CHESS INTELLIGENCE.

An International Chess Tournament is now in progress at Monte Carlo. There are twenty competitors, Dr. Lasker, who now holds a mathematical post at Owen's College, Manchester, and Messrs. Blackburne and Burn being the most notable absentees. A feature of the tournament is the return of Dr. Tarrasch to public play. The score will be given next month.

A Collection of Seven Hundred Chess Problems, by Mrs. W. J. Baird, is announced for publication this month by Messrs. Sotheran & Co. The diagrams will be printed in colours, and the volume will contain a portrait of the author. The edition will be limited to 500 copies, the price being 10s. 6d. net.

THREE-MOVE PROBLEM TOURNEY.

1*st Prize, One-and-a-Half Guineas;* 2*nd Prize, Fifteen Shillings;* 3*rd Prize, "Knowledge" free for* 12 *months.*

The Conditions are as follows:—

1. Each competitor may send not more than one three-move unconditional direct-mate problem (diagrammed).
2. Competing positions must be original and unpublished.
3. Each problem must be accompanied by a motto and full solution, with a sealed envelope containing the composer's name and address.
4. Competing positions much reach Mr. C. D. Locock, Netherfield, Camberley, England, on or before April 10th, 1902.
5. The Chess Editor reserves the right of excluding manifestly impossible, unsound, or inferior positions.
6. The adjudication will be partly by solvers and partly by the Chess Editor.

All solvers who solve correctly every problem will be entitled to vote on their merits. The six or eight problems thus selected will then be adjudicated on by the Chess Editor, whose decision will be final.

A Solution Tourney will commence in the May number. Full particulars will be given next month; in the meantime it may be stated that the winner will hold for 12 months a Silver Challenge Trophy, which will become his property should he win it three years in succession, or four years altogether. Second and Third Prizes will also be given, viz.: 15s., and Knowledge for one year respectively.

The Challenge Trophy consists of a silver Castle on an ebonised pedestal, the whole standing $7\frac{1}{2}$ inches high; the silver portion being 6 inches high. The Trophy is adorned with shields for the inscription of the title and winners' names.

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(About half natural size.)

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CONTENTS.

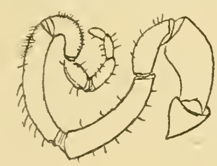
THE NOBODIES,—A SEA-FARING FAMILY.

By Rev. T. R. R. Stebbing, M.A., F.R.S., F.L.S.

CHAPTER II.

A maker of proverbs has asserted that the unexpected always happens. Yet there would be something tedious and paradoxical in always expecting it. Even the frequency of its occurrence, however proper to be urged as an inducement to thrift, is little more in itself than a measure of human ignorance. As a rule parallels are soon found to things that at the first glance appear unique or completely unconventional. Our present subject may seem to have even less connexion with the Chinese empire and archaic customs in the south of France than with toads and fishes. Yet all these can throw a certain illustrative light upon it. The Chinaman is said to make an excellent nursemaid. By the custom of the couvade in Provence, when a child is born, it is the father who takes to his bed. The Surinam Water Toad, *Pipa americana*, carries her eggs when laid and until hatching in little pits on her back. If you wonder how they get there, you are told that the arrangement is due to the skilful care of the male parent. Among the so-called pipe fishes it is no longer a question of easing the mother's burden by a transfer of the eggs from one part of her body to another. Her mate takes upon himself the entire charge of them. Either they are gummed to his yielding and solicitous breast, or as a masculine marsupial he receives them into the safe keeping of a special ventral pouch. How little such things fall in with ordinary and long prevailing ideas of what is natural may be judged from the following narrative.

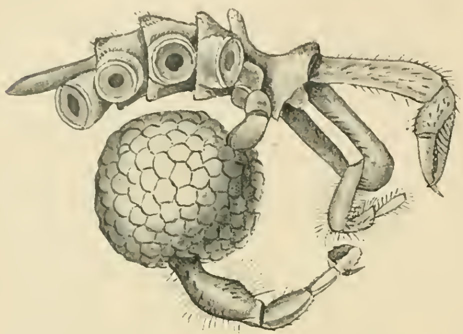
It has been already explained (Knowledge, Vol. XXV., p. 39) that in the Pycnogonida there are normally seven pairs of limbs or appendages more or less limb-like. In sound adult specimens the last four pairs are always present, but of the first three one pair may fail, or two, or all. It is with the third of the first three that we are immediately concerned. These are always much slighter and shorter, though they sometimes have more joints, than the long clambering legs behind them. Their attachment too is somewhat different, being rather ventral than expressly lateral. Those that are most numerously jointed have the last three, or four, or five joints coiled in a helpless looking way, and anyone regarding these appendages as walking-legs might be inclined to think them a



Ovigerous leg of *Pallenopsis fluminensis* (Kröyer). After Meinert.

mistake or a case of arrested development. He would perhaps congratulate the genera and species that had dispensed with organs so inefficient. Quite at the outset, however, in the history of the group, it was observed that these appendages when present had one important function for which they were well fitted, that of carrying the eggs. Obviously for the naturalist they carried likewise the advantage of enabling him without trouble to decide the sex of his specimens, whenever the ova happened to be present. The ingenious Dutchman, Job Baster, previously mentioned, having many specimens of *Pycnogonum littorale* at command, had further observed that some of them were entirely devoid of these ovigerous legs. That was still more convenient, as making clear the sex of the specimens, whether the eggs happened to be present or not. For eighty years indeed this facility was upheld by scientific teaching, till in 1845 it was demolished by Henrik Kröyer, the masterly naturalist of Denmark, who pointed out that in several genera and species the appendages of the third pair were constantly present, whether the specimens were male or female. In 1849 M. Dujardin published the mystifying account of a *Pycnogonum littorale* which had eggs ready to be laid, but no ovigerous legs on which to lay them. A similar specimen was described by Dr. P. P. C. Hoek in 1877, and a female *Phoxichilidium* in like circumstances by Dr. Semper in 1874. Dujardin left the difficulty alone.

Semper thought that the legs would be developed by the time they were wanted. Hoek inferred that some females could do without them. Hoek was right so far as he ventured to go. A still more complete solution of the enigma, which had remained unsolved for more than a hundred years, was on the eve of being published. In the same year, 1877, the Italian author Cavanna announced the surprising but no longer deniable fact that it was not the female at all but the male on whose ovigerous limbs the eggs were supported. There may be but a single clump carried by the two legs in common, or on each leg a packet, or several packets, or the eggs distributed singly.

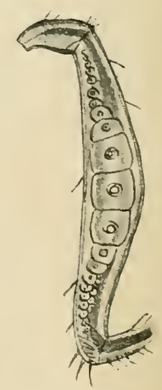


Lateral view of *Chætonymphon hirtipes* (Bell); the walking legs omitted. After Sars.

Whatever the variations of arrangement, a large clutch of small eggs or a small clutch of large eggs, or otherwise, with them all it is the father that is the fostering nurse. Nor does he undertake the duty in any casual way, without the highly-developed preparedness that befits so tender an office. Seeing that he may upon occasion be required to take charge, not of twins or triplets merely, but of a thousand eggs in one cargo, it is just as well that he should have some appliances ready for this multiple trusteeship. Now, as explained by Dr. Dohrn ("Die Pantopoden des Golfes von Neapel," pp. 33, 67), in all males but not in the females of the Pycnogonida the fourth joint of the ambulatory legs is provided with a gland which through apertures one or many exudes a viscid secretion. Dohrn, probably with an eye to the masquerading ingenuity of spider-crabs, proposes to explain the use of this cement as enabling the animals to coat themselves over with extraneous articles. To this Hoek pertinently objects that in the economy of this group adhesive patches from the outside world or disfiguring disguises of any sort are very far from being coextensive with the occurrence of the glands. Besides, a much better explanation is available. Since Dohrn himself specializes the glands as a masculine feature, one can scarcely refrain from agreeing with Hoek's suggestion that their purpose is to agglutinate the eggs about the appropriate paternal limbs. Nevertheless it must be admitted that in one remarkable genus to be hereafter noticed, though there are ovigerous legs in both sexes, no observers have yet found these legs with ova adherent to them in either sex. Also in a solitary example of *Nymphon brevicaudatum*, Miers, Dr. Hoek found the exceptional combination of highly-developed ovaries and a distinct egg-mass on the ovigerous leg. The explanation of this might be that a female specimen had casually developed a male characteristic, or that a father not too seriously devoted to his domestic duties had for once stuck the eggs on to his wife's leg instead of his own.

Since many females retain these limbs, on which perhaps in a past age they regularly carried the ova though they carry them no longer, the enquiry will be made, why do they still retain the limbs without the office? The answer to this is that they have an additional function which explains their retention. Only, this answer does not seem very flattering to the females which have given up the limbs. For the function intended is that of cleansing feet. For this no doubt they are as well adapted as the paw of the domestic cat or as the curiously modified appendages in some of the Entomostraca, which the Germans have called Putzfüsee or dressing-legs. One may charitably suppose that the female Pycnogonids no longer possessed of this wholesome apparatus satisfy decorum by employing in its stead the larger but very similarly constructed ambulatory limbs. The latter in this community show no averseness to the adoption of anomalous functions.

The attendance of the males on the business of the nursery is susceptible, as we have seen, of illustrative comparisons. Not so easily will a zoologist, by appealing to common fame, detract from the uniqueness which the other sex exhibits in the position of the ovaries. To the thorough philosopher and to the thoroughly ignorant all things are much on a level as alike miraculous or alike common-place, but to the general ruck of us who know just enough to derive pleasure from knowing more, the discovery that eggs can be developed in a creature's leg is generally when first made an exciting experience. In the famous apologue by which Menenius Agrippa drew back to their allegiance the revolted populace of Rome, his point was that the body politic resembles the organization of an animal, in which, however active and hardworked and unpampered the limbs may be, they would speedily lose their place and power in the world, were it not for all that goes on in the trunk to sustain the life of the individual and secure the permanence of the species. A plebeian, a proletarian, with natural knowledge some two dozen centuries in advance of his age, might have answered that there was no absolute need for any such monopoly on the part of the trunk; that in the Pycnogonida, small animals abounding on the shores of Italy, the limbs had asserted themselves and known how to reduce the body to proper subordination and insignificance. This at any rate is the case, that in the marine animals we are now considering nature has chosen to follow a course different from that pursued in mites or myriapods, insects or crustaceans, spiders, harvestmen, or scorpions. Here only, so far as at present appears, have we the intestine of both sexes and the ovary of the female prolonged far into the limbs. Many of the species have an integument sufficiently transparent to exhibit these intra-crural peculiarities without the least pretence of prudery. *Pallene brevirostris*, Johnston, first recorded from Great Britain but by no means confined to our islands, is one of these pellucid species. That the same or closely related, forms have been variously named *empusa*, *phantoma*, *spectrum*, as though they were disembodied spirits, is due to that corporeal meagreness which is more or less



Fourth joint of an ambulatory limb of *Pallene brevirostris*. After Sars.

characteristic of the whole group. There is also a *Pallene emaciata*, the starveling Pallene. Some may be inclined to suggest that it was this very tenuity of the almost evaporating trunk that put a force upon nature to make a grotesque use of the jointed legs. Nothing of the kind can be truly urged. In the Caprillidea, where also such names as spectre-shrimp and skeleton-shrimp are applicable and have actually been applied, and in equally thread-like amphipods of the genus *Rhabdosoma*, no such device is made use of. Nature there arranges that the intestinal and ovarial apparatus shall be in their ordinary situation, and, as though to prove an unfettered independence of action, goes about in those very instances to diminish the number or the size of the jointed limbs.

Pallene brevirostris, Johnston. After Sars.

From the figure of Pallene it will be seen that the eggs are formed in the dilated fourth joint of the walking-leg. This is their usual position, and they occur not in one leg only but in each of the eight. The sexual openings of both male and female are in the second joint. As a rule those of the female are found in the second joint of all the eight legs, those of the male only in the last two pairs, though sometimes in the last three or limited to the last pair of all. The genus *Pycnogonum* has them for both sexes only in the last pair of legs. Though so strangely ramified and well provided with orifices the ovary is found to be, strictly speaking, a single structure. This, however, is subject to the presumption from analogy that at a particular point of the body two members of an original pair have coalesced. The ovarial prolongations usually extend only to the end of the fourth joint of the leg, but Dr. Dohrn describes a species, found commonly in the Bay of Naples, and named by him *Clotenia conirostris*, in which the ovaries extend to the end of the sixth joint in all the legs, " producing along the whole stretch ripe eggs which are of considerable size and give the legs a striking appearance."

The number of eggs that are laid, or at least that the male has to take charge of at any one time, is very variable. In the genus *Pallene*, Professor Sars and Dr. Dohrn call attention to the fewness of the eggs. In the British species *P. brevirostris*, Sars says that they are as a rule about six on each leg, and he speaks of them as similarly few in number in *P. producta*, a species which he describes from Norway. A specimen, however, taken off Millport in the Clyde, having characters which seem to justify its identification with *P. producta*, carries thirty-eight eggs in one packet and forty-six in the other. This species does not appear to have been previously recorded from Great Britain.

An Irishman explained the want of hospitality from which he had suffered by saying that no one had thought of asking him, Have you a mouth, Patrick? In the Pycnogonida there is indeed a mouth, though to match the rest of the structure a peculiar one, of which the description must be deferred to a later opportunity. It is mentioned here as undoubtedly the orifice through which food is introduced, and because it leads as usual into the intestine of which some other characters are so very unusual. It might be thought singularity enough for an alimentary canal to push prolongations through numerous joints of the strongly geniculating limbs and sometimes also into the proboscis of its owner. But this is not sufficiently exceptional by itself to satisfy the Pycnogonida. With crustaceans the intestinal tube, whether it be straight or curly, is very commonly made conspicuous to the observer and defined throughout its course by its dark and compact contents. There is a column of residual matter from the food which has served its purpose of alimentation. There are arrangements for the expulsion of these waste products from the body. But in the Pycnogonida no such residuum is perceived, even when their bodies are so translucent as to show clearly the ganglia and commissures of the nerve-chain. No naturalist appears to have witnessed in these animals that expulsion of reliquiæ, of which most arthropods and vertebrates are at little pains to make any concealment. There are, however, the requisite muscles for opening and closing the aperture of the caudal segment, and of this Dr. Meinert remarks that "the intestinal canal opens in the end of it with a weak squirting apparatus." But Meinert's observations were made on preserved specimens, whereas Dr. Dohrn says: "In spite of hundreds of observations of living Pycnogonida under the microscope I have never seen the exit of solid material from the terminal orifice, nor ever remarked coloured fluids in the end part of the intestine." He is driven, therefore, to suppose that these creatures can avoid importing into their organism anything indigestible, or that they can in some way absorb all that they actually swallow. It seems a truly ethereal system of eating and drinking. Dohrn thinks that it may help to explain another difficult point. The Pycnogonida have no tracheæ, no lung-books, no branchiæ, and in Dohrn's opinion the integument is not permeable for that interchange of gases which is necessary to respiration. Yet they must breathe, and as the terminal aperture has been redeemed from vulgar uses and left with nothing to do, he lets them

Barana castelli, Dohrn. Only appendages of right side shown. After Dohrn.

breathe through that. Hoek inclines to think this solution of the problem rather rhapsodical, or as one might say Aristophanic.* He prefers to believe that the skin is in

* *See* Aristophanes, The Clouds, line 159, but compare also Huxley, The Crayfish, note viii., p. 353.

truth respiratory. Whatever the right explanation may be, Dr. Dohrn was encouraged in his view of the matter by an incidental result to which other investigations gave rise. He cut in two a specimen of his species *Barana castelli*, for the sake of examining its anterior half. The remnant, which comprised the last three pairs of legs, was thrown back into the water. To his astonishment this *dimidiata Barana*, this headless section, the brainless hind-quarters of an animal, "lived for many weeks, the movement of the fluids of the intestine and body went regularly on, the creature moved its limbs completely like an undamaged specimen, even the eggs appeared to grow more and more mature." Once again it must be allowed that if not the wholly unparalleled, at least the very much unexpected had come to pass. In detachment the leg of a "harvestman" (Phalangium) by its long-continued twitchings presents an uncanny and reproachful appearance, but that is only faintly comparable with the spook-like behaviour of this Barana, which walked and all but talked weeks and weeks after its head was cut off.

VEGETABLE MIMICRY AND HOMOMORPHISM.—II.

By Rev. Alex. S. Wilson, M.A., B.Sc.

The curious shapes of some exotic orchids are probably advantageous from their resemblance to insects and birds. One of our native orchids *Listrea ovata* has a

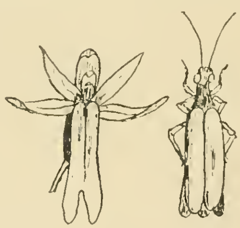


Fig. 3.—Orchid and Beetle.

flower which in shape decidedly resembles a species of beetle, *Grammoptera lævis*, by which it is fertilised. Perhaps in this case the insect mimics the flower, as certainly happens with a pink-coloured Mantis in Java, which so exactly resembles a pink orchid that butterflies are attracted to it in mistake. The insect is carnivorous, and lies in wait for its prey, which is easily secured by the help of this strange disguise. Mutual resemblances of this description are rather characteristic of the Orchidaceæ. From their resemblance, real or fanciful, to butterflies, moths, bees, spiders, &c., various species

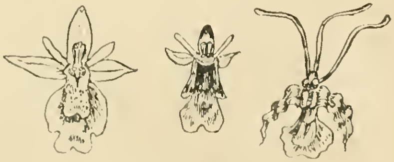


Fig. 4.—Orchids resembling Insects.

of *Habenaria*, *Neotinea* and *Ophrys* derive their names—the butterfly, spider, bee and fly orchises.

In the orchid *Ophrys muscifera* are two little protuberances regarded by the late H. Müller as pseudo-nectaries. Of this class of deceptive contrivances, however, we have a better example in *Parnassia palustris*, one of the saxifrages. This flower has five fan-like scales alternating with the stamens; the margins of the scales

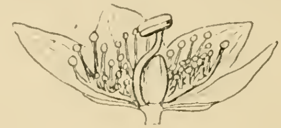


Fig. 5.—Pseudo-nectaries of *Parnassia*.

are fringed with hair-like processes, and each hair is capped with what appears to be a drop of honey. These are really hard dry knobs, but so much do they resemble drops of honey that flies lick them before discovering the imposture. The intention of these sham nectar-drops may either be to decoy unprofitable guests from the real nectar, of which a limited supply is produced in the hollow of each scale, or to advertise it for the benefit of the more intelligent visitors.

Somewhat analogous to these pseudo-nectaries are the greenish swellings which arise on the veins of the petals of *Eremurus*. These little swellings present a striking resemblance to aphides or plant-lice, and Kerner states that a fly accustomed to hunt after aphides pierces and sucks the swellings, apparently mistaking them for the insects.

Relations which remind us of the pink orchid and Mantis mentioned above, seem to exist between the little bladders of *Utricularia* and the entomostracans. The bladder-wort is a carnivorous plant with small submerged vesicles in which minute insects and entomo-

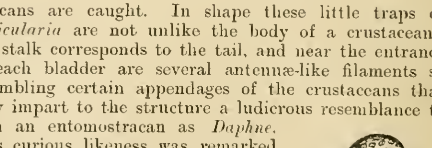


Fig. 6.—Bladderwort and Entomostracans.

stracans are caught. In shape these little traps of *Utricularia* are not unlike the body of a crustacean; the stalk corresponds to the tail, and near the entrance of each bladder are several antennæ-like filaments so resembling certain appendages of the crustaceans that they impart to the structure a ludicrous resemblance to such an entomostracan as *Daphne*. This curious likeness was remarked by Mr. Darwin and can hardly be altogether accidental; perhaps the prey is more readily induced to approach the snare by reason of the resemblance. Here also may be mentioned the imposture practised on its victims by *Darlingtonia*, another insectivorous plant. In the hood of its pitcher-like leaf are several transparent spaces through which the light shines into the interior; to these the imprisoned flies are attracted and thereby diverted from the only opening through which escape is possible. Mistaking the

Fig. 7.—Leaf-pitcher of *Darlingtonia*.

"windows" for real openings the captives exhaust themselves in vain efforts to regain their liberty and are ultimately precipitated into the depths of the pitcher.

The flowers of the ox-eye daisy and the feverfew are very much alike, and this was adduced by the late Mr. Grant Allen as a possible case of mimicry. But the probability is that in this instance the resemblance is merely homomorphic. The colours of flowers are distinctive as well as attractive. Where two species of plant grow together and are in blossom at the same time it is to their disadvantage to have the flowers of the one mistaken for those of the other. To secure cross-fertilisation it is needful that the insect visitors pass from one flower to another of the same species, otherwise the pollen will be conveyed to the stigmas of the wrong species. It is of importance that the fertilising agents should be able readily to distinguish different flowers, and this is no doubt one reason for the diversity of their colours, shapes and odours. This circumstance must operate as a check against the production of mimetic blossoms; it will not, however, prevent flowers from acquiring a likeness to any object other than a flower.

Mimetic resemblances are much more numerous among fruits and seeds than in flowers. A very curious example is *Ophicaryon paradoxum*, the snake-nut of Demerara, inside which is the coiled embryo resembling a small snake. Among others mentioned by Lord Avebury are *Tricosanthes anguina*, the pod of which assumes a snake-like guise; *Scorpiurus vermiculata*, with

Fig. 8.—Mimetic Seeds.

pods in the form of a worm or caterpillar; *S. subvillosa* and *Biserrula pelecinus*, where the resemblance is to a centipede and certain lupines with spider-like seeds. The seeds of *Abrus precatorius*, *Martynia diandra*, *Jatropha*, the castor oil plant and the scarlet runner mimic certain beetles. The presence of a caruncle representing the head of the insect renders the imitation more complete; this structure takes no part in germination, and Kerner is of opinion that it prevents the ants from attacking the substance of the seeds which they drag about from place to place. The ox-tongue and cow-wheat have worm-like seeds, and several plants have fruits difficult to distinguish from little pieces of dry twig. The jet-black, shining seeds and achenes of *Delphinum*, *Helleborus*, *Juncus*, *Atriplex*, *Polygonum*, etc., are easily mistaken for beetles; the brightly coloured seeds of *Iris Germanica* are also in all probability mimetic.

The beautiful glossy scarlet and black piebald seeds of *Abrus* known as rosary beans perhaps escape destruction through birds mistaking them for some nauseous insect gaudily attired in warning colours. But from the manner in which the seed vessels of *Iris* and *Abrus* dehisce and expose their seeds the brilliant colours of the latter would appear to subserve dissemination rather than protection. Such hard seeds are probably dispersed through the agency of insectivorous birds, which seize them in mistake for their more legitimate prey. According to Lord Avebury the beans of *Abrus* mimic the beetle *Artemis circumusta*. The smaller seeds known as crab's eyes are coloured in an analogous manner. These cases are the less surprising if we have regard to the fact that the great majority of dry fruits,

Fig. 9.—Piebald Beans of Abrus.

though green while growing, become black or brown when they fall to the ground, so that their general tint corresponds with their surroundings and tends to concealment.

THE ARCETRI OBSERVATORY, FLORENCE.

By W. Alfred Parr.

The beautifully illustrated *brochure** on the Arcetri Observatory, just issued by its Director, Prof. Antoion Abetti, draws attention to an institution which, standing as it does on the classic ground dedicated to the memory of Galileo, and overlooking the broad valley of the Arno, possesses an interest equalling that of many a larger and better known observatory. As far back as the year 1774, Florence, which could justly claim to be considered the intellectual capital, as it was nearly a century later, if but for a short period, the political capital of Italy, possessed a small observatory divided into an astronomical and a meteorological department, which formed part of the building of the Museum of Science and Natural History, occupying a wing of the Pitti Palace, in the Boboli Gardens. The history of this museum is in itself of extreme interest, as it was established under the rulers who succeeded Ferdinand II., Grand-Duke of Tuscany (1621-1670), during whose reign was founded its more celebrated predecessor, the famous *Accademia del Cimento*, itself called into existence by the works of Galileo and his school.

Among the earlier astronomers who worked at the Florence Observatory may be mentioned De-Vecchi, who died in 1829, and Pons, celebrated for his cometary researches. Amici, who succeeded Pons in the directorship, was a noted physicist and optician of his time, and did much to re-establish for Florence the reputation it had enjoyed in Galileo's time as a centre for the construction of optical instruments. Amici's objectives were justly celebrated, one of his best and, at that time, one of the largest in existence being the excellent 11·5-inch object-glass still in use at the Observatory. The chief astronomical activity of Florence, however, may be said to have commenced with Donati, who, towards the end of 1859, succeeded Amici as Director of the Observatory, and through whose exertions principally the astronomical department was transferred to its present more favourable position on the hill of Arcetri, to the south of the city and quite close to the villa where Galileo died. Donati, who commenced the construction of the new observatory building in 1869, had already become universally known

* "L'osservatorio Astronomico di Arcetri; Appunti Storici ed Illustrazioni." Firenze, 1901.

in connection with the great comet which bears his name. This comet, detected by him in Florence as a faint nebulous spot, on June 2nd, 1858, developed in a few

Arcetri Observatory, Florence (South Front).

months' time into one of the most superb celestial spectacles ever witnessed, its nucleus rivalling Arcturus in splendour, while the tail extended over an arc of forty degrees, forming a magnificent object in the autumn skies of that year which it graced for one hundred and twelve days. The building operations, which lasted some three years, being completed, the new Observatory was formally opened on October 27th, 1872. Donati, however, was unhappily not destined to long enjoy the advantages of its improved position, for he died suddenly on September 19th, 1873, but forty-seven years of age. For a brief interval, under the care of an assistant, the Observatory came, in 1875, under the management of Tempel, who, adding the skill of an accomplished draughtsman to his accuracy as an observer, executed a quantity of very beautiful drawings of nebulæ with the aid of the Amici equatorial, noticed above, and smaller instruments. During Tempel's directorship, however, certain structural defects had made themselves apparent, so that at his death in 1889 considerable alterations were undertaken which have brought the building and its instrumental equipment into line with the most exacting modern requirements, and, under the present Director, the Observatory has taken up an important position among the observatories of Italy.

Such, in brief, is the history of an institution which may be said to have sprung directly from the founder of observational astronomy, and it was but fitting that Prof. Abetti, in his inaugural address delivered at the re-opening of the University of Florence for the present session, should have drawn attention to the close relationship existing between Galileo and his school, and the Arcetri Observatory. Indeed, the spirit of Galileo seems to pervade the classic hill of Arcetri on which the Observatory stands, for close by lies his villa, il Gioiello, where he was visited by Milton, in 1638, and where he spent the declining years of his life, having been chiefly attracted towards this spot by reason of its proximity to the Convent of San Matteo, where his two daughters, Suor Maria Celeste and Suor Arcangela, lived as nuns. It was in this villa that Galileo sought retirement after returning, still a prisoner, from his memorable visit to Rome, whither he had been summoned by Pope Urban VIII. to abjure before the tribunal of the Inquisition the "heresies" of the Copernican doctrine; and it was here that his favourite daughter, Suor Maria, undertook the filial task of reciting weekly the seven penitential psalms which formed part of her father's sentence. Now it was that the great astronomer was justly characterised by Byron as "the starry Galileo with his woes," for he was soon struck with total blindness. "The noblest eye," as his friend Castelli expressed it, "was darkened—an eye so gifted that it may be said to have seen more than the eyes of all that are gone, and have opened the eyes of all that are to come." His death followed but a few years afterwards, on the 8th January, 1642, when he was in the seventy-eighth year of his age.

Its associations alone would thus ensure for Arcetri an honoured position among observatories, quite apart from the fact that it occupies a site which, for historic interest and natural beauty of surroundings, is almost without a rival in Europe. Standing on the terrace of the Observatory, the eye ranges over a magnificent prospect, which is bounded on the eastern horizon by the wooded heights of Vallombrosa, and on the western by the distant Carrara Mountains, while southward lie the beautiful hills of Chianti, and on the other side, Fiesole, and the lofty spurs of the Apennines, at whose foot lies Florence in the broad "valley down which the yellow Arno steals silently through its long reaches to the sea."

ASTRONOMY WITHOUT A TELESCOPE.

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

XII.—THE MARCH OF THE PLANETS.

The nightly procession of the stars across the sky was not the only celestial movement which impressed the observers of old. The coming and going of the planets held an even stronger attraction for them, and the mystery of their wanderings, which seemed at first sight to be so lawless, was the subject of much deep speculation. But this field of work has been so completely occupied in modern times by the transit circle and allied instruments that it is now hopeless for the "Astronomer without a Telescope" to dream of obtaining results of any real value. The only thing that he can do is to imitate his forerunners and to familiarise himself with the apparent motions of the planets as they present themselves to the naked eye.

In this work he will find that the five planets within the reach of his unaided sight divide themselves into three groups. The first group includes Mercury and Venus, which moving in orbits interior to that of the earth, can never come into opposition to the sun, but oscillate backwards and forwards on either side of him. Both of them are therefore most easily observed when they are at their elongations. Of the two, Mercury, being much the least bright, since he is smaller, and has a less reflective surface than Venus, is by far the more difficult object, a difficulty increased by the fact that his elongation cannot under the most favourable conditions amount to 28°, whilst the greatest elongation for Venus is nearly 48°. For reasons corresponding to those which were considered in the preceding chapter as regulating the most favourable conditions for observing heliacal risings and settings of stars, the most favourable position for Mercury to be seen as an evening star is when his eastern elongation occurs near the spring equinox; his most favourable position for observation as a morning star is when his western elongation occurs near the autumnal equinox.

Comparatively few dwellers in England have seen Mercury with the naked eye, unless they have persistently searched for him, and hence the idea has arisen that there was something very remarkable about the knowledge which the ancients had of this planet. But as Colonel Markwick remarked in a paper in Knowledge (July, 1895, p. 152)—"To anyone who has seen that planet in the latitude of Greece, it would seem a most remarkable thing if the planet had not been seen and noted as such." This proceeds partly from the climates of Chaldea, Egypt and Greece being far better than that which we possess here in England. But in addition to this the greater nearness to the equator of these countries involving that the daily path of the sun and planets was more nearly perpendicular to the horizon, and that twilight was much shorter, gave them an immense advantage over us for observing this planet.

The interval between an east elongation of Mercury and the following west elongation is a little over six weeks, Mercury passing between the sun and the earth in the meantime. The interval from west elongation to east elongation, Mercury passing behind the sun, is a little over ten weeks, the mean periods being 43½ days and 72½ days respectively. The mean interval therefore from one elongation to the same elongation again is 116 days. Since therefore Mercury goes through the complete cycle of his positions with regard to the sun in a little under four months, there must be at least one favourable configuration in every year. In general there will be two or three. The attentive watcher therefore should have no difficulty in catching sight of the elusive little planet at at least one elongation in each year.

The motions of Venus are similar in character to those of Mercury, but are performed more slowly, and the arc through which she swings is a wider one. The mean period from east elongation as an evening star to west elongation as a morning star is 143 days, whilst it is 441 days from west elongation round to east; the entire synodic period therefore being 584 days. There is of course no difficulty at all in recognising Venus when she is near her elongations for she is then the most brilliant star in the sky, but some interest attaches to her changes of brightness. These changes depend upon two circumstances: the one, the distance which she is from the earth, and consequently the apparent size of her disk; the other, upon the amount of that disk which is lighted up by the sun, in other words upon her phase angle. The disk is greatest when Venus is between the earth and the sun, but at such a time the face she turns to us is necessarily in darkness. On the other hand, when she is in superior conjunction, that is to say on the further side of the sun, her disk is entirely illuminated, but it is then at its smallest size. In both cases she is invisible since she is in full sunlight.

At elongation her disk is much larger than at superior conjunction, so much larger indeed that though it then appears like a "half-moon," it gives us three times the light which it would do could we observe it when it was full. But as she passes from east elongation towards inferior conjunction, the increase in apparent size compensates, and more than compensates for the decrease in phase, until half-way between the two positions her light is four times that at superior conjunction. From this point the effect of phase is greater than that of increase of size. The time of greatest brilliancy therefore is some 36 days before inferior conjunction, and again 36 days after. Then a period of 512 days will ensue before Venus returns a second time to her greatest brilliancy as an evening star. And as five times 584 days—the synodic period of Venus—is almost exactly eight terrestrial years, it follows that at intervals of eight years the times of greatest brilliancy recur on almost the same dates.

At her greatest brightness, Venus is so brilliant that there is no real difficulty in seeing her with the naked eye in full sunshine, or indeed at high noon. The hindrance is not the want of brightness of the planet, but the difficulty in picking up so minute a point of light as she appears to be, unless some means is provided for guiding the eye to the precise spot. When so found the first impression is—"How could I possibly have overlooked so bright an object?" The next impression, if the eye be turned from the planet but for a moment is—"What a hopeless task it is to try and find it again!"

The statement has sometimes been made that the phase of Venus may be seen under exceptional conditions with the naked eye. Frankly I think this observation lies outside the limit of possibility; for Venus at her greatest brilliance is only about 40 seconds of arc in diameter. Now 40 seconds is practically the limit for distinct defined vision, and it is very improbable that the precise shape of Venus could be detected under such circumstances. It would, however, be interesting to know if any one could detect that the planet was not round. It is just possible that an impression of elongation might be given, though this would show exceptionally keen sight.

The second group of the planets includes Saturn and Jupiter, which both move in orbits far outside that of the earth. From the point of view of the naked-eye astronomer, neither is of very great interest. Their movements do not greatly differ from those of the stars, amongst which they move but slowly. Like the stars they will have their heliacal risings, being seen as morning stars in the east just before sunrise. Rising earlier and earlier the time comes when they are visible for the entire night. But before they are in opposition to the sun, that is to say, are on the meridian at midnight, there is a striking change in their apparent motion amongst the stars. For the greater part of the year, Saturn is moving eastwards amongst the stars at an average rate of a degree in about eight days. Jupiter traverses the same distance in about half that time; but gradually as the time of opposition draws on, the speed of both planets diminishes, until Saturn comes to a stop about 70 days before opposition, and Jupiter about 60. Then for 143 days Saturn moves westward, and Jupiter for 122, both planets becoming stationary again at the end of the period, and then resuming once more their eastward march. This period of westerly movement or retrogression marks the time when the planet is nearest to the earth and therefore brightest, and it is at the middle of this period that the planet is in opposition, that is to say, is on the meridian at midnight.

Just as it has been asserted that the crescent of Venus has been seen with the naked eye, so it is also asserted, but on somewhat better authority, that the satellites of Jupiter have been seen at their elongations from their primary, and though of course it is utterly beyond the unaided sight to perceive the ring of Saturn, the claim has been made that Saturn has been observed as an elongated, not as a circular point of light. By a curious coincidence it happens that the diameter of Jupiter at opposition, the major axis of Saturn's ring, and the diameter of Venus at greatest brilliancy, are all very nearly equal, and all are very near the limit of defined vision. It follows therefore that the Saturn observation is as difficult as that of Venus, but the satellites of Jupiter are not quite so hopeless. The first and second are always too close to their primary to be seen apart from it, and they are probably too faint as well. But the third would be very readily visible if it were a solitary star, and at its greatest elongation from the planet it is distant from it $5\frac{3}{4}$ minutes of arc, one-sixth of the apparent diameter of the moon. Many people can separate ϵ_1 and ϵ_2 Lyræ which are considerably nearer to each other. The fourth satellite attains a distance at greatest elongation of nearly ten minutes of arc, a distance amply sufficient to separate it from Jupiter, but is by no means so bright an object as the third. The story of Wrangel, the celebrated Russian traveller, quoted by Mr. G. F. Chambers from Arago, that when in Siberia he once met a hunter who said, pointing to Jupiter, "I have just seen that large star swallow a small one and vomit it shortly afterwards," is a beautiful specimen of the traveller's tale. Wrangel explains the hunter's remark as referring to an immersion and subsequent emersion of the third satellite. It escaped Arago's notice that it takes the third satellite over a week to pass from one elongation to another, and that further, as the satellite would have reappeared on the opposite side of Jupiter from that on which it disappeared, the hunter would have scarcely described the incident as he did.

An opera-glass of course easily shows the satellites of Jupiter, and one optically perfect should suffice to elongate Saturn when the ring is fully open or show the phase of Venus at greatest brilliancy.

The movements of Mars are sufficiently different from those of the other four planets for him to be considered by himself; the chief features in his case being the length of time in which he remains out of sight on the far side of the sun, and the very great difference between his apparent size when nearest to the earth and when farthest from it.

The East Horizon at 2 a.m. on the morning of 1881, June 22.

The synodic periods of Mercury and Venus stated above are 116 and 584 days respectively; those of Jupiter and Saturn are 34 and 13 days longer than an entire year, but the synodic period of Mars is 50 days more than two years. During the greater part of this time he is moving eastward amongst the stars at a pace of only a little less than a degree a day. As he approaches opposition his pace slackens down until, like Jupiter and Saturn, he becomes stationary and then recedes for a time westward. This period of recession begins about six weeks before opposition and lasts about six weeks after.

The chief interest of Mars, as a subject of observation without the telescope, is the opportunity which he gives, especially when he is in the more distant parts of his orbit, and therefore relatively fainter, to compare him as to his brightness with the stars near to which he passes. This is a work which needs doing, and which anyone could undertake, yet it has been almost entirely neglected.

Three other planets are just within the limits of visibility under favourable circumstances, Uranus, Ceres and Vesta. To these we may now possibly add a fourth, Eros. But while the three above mentioned might be seen at any opposition, Eros, if ever bright enough, will only be so at one opposition in thirty-seven years.

One feature of the planetary march will always attract attention and give pleasure to the observer, even though no practical result be drawn from it; that is the way in which from time to time two or more of them will come into close proximity to each other, or it may be to some bright fixed star or to the moon. Thus on September 15, 1186, all the five chief planets were in conjunction together in the constellation Virgo to the east of Spica. In much more recent times, four of the five chief planets came together in the constellation Aries, Mercury being the only missing member, and this conjunction was made the more impressive by the presence in the midst of the group of the waning moon. This beautiful spectacle was witnessed in the early morning of June 22, 1881.

ORIGIN OF A DISTURBED REGION OBSERVED IN THE CORONA OF 1901, MAY 17—18.

In a preliminary report* of the observations of the Sumatra eclipse by the Crocker Expedition from the Lick Observatory, I called attention to an unusual area of disturbance in the corona in the north-east quadrant. At the time of writing that report no observations of the Sun's surface were available from which to investigate the source of this disturbance. Through the courtesy of the Astronomer Royal, Royal Observatory, Greenwich, we have received a set of positives on glass of negatives of the Sun taken at Dehra Dûn, India, on May 17th, 18th, 19th, 20th, 21st, 22nd, 26th, and 28th, 1901. These photographs are on a large scale, $7\frac{1}{2}$ inches to the Sun's diameter, and furnish the desired observations. They show an intimate connection between activity on the Sun's surface as observed in the sun-spots and faculæ, and the corona.

The photographs of May 17th and 18th show no spots or other evidences of activity on any part of the Sun's disc. This absence of spots was noticed before the eclipse at the station in Sumatra. The photograph of May 19th, however, shows a medium-sized spot which has just come into view around the east limb. On this date the spot is little more than a line, owing to foreshortening, $\frac{1}{2}'$ in length surrounded by faculæ. On the 20th it is $\frac{3}{4}'$ in length (*i.e.*, north and south), followed at a distance of $\frac{1}{2}'$ by several small spots forming a close group. On all sides of the group, except the preceding or west side, is a large area of faculæ. The principal spot is compact, with well-defined umbra and penumbra, and shows no more changes from day to day than are usually observed in the same period. The group of small spots following, however, shows traces of greater activity, principally growth.

Following are the co-ordinates of the principal spot deduced from the plates of May 19th and 28th, the longitudes being measured from the centre of the disc:—

	Greenwich Civil Time. h. m. s.	Longitude. °	Latitude. °
1901 May 19	3 30 37	80·7 East	+ 9·0
28	7 29 37	46·7 West	+ 9·0

From these positions are deduced the following co-ordinates of the spot at the time of the eclipse in Padang:—

	Greenwich Mean Time. h. m. s.	Longitude. °	Latitude. °
1901 May 17	17 40 37	93·8 East	+ 9·0

From this it will be seen that the spot was on the opposite side of the Sun at the time of the eclipse and within 4° of the limb. Following are the position angles of the spot as projected on the limb, and of the apex of

* Lick Observatory Bulletin, No. 9.

the disturbed area in the corona observed on the eclipse negatives :—

	Position angle.
	°
Sun-spot	60·2
Apex of Coronal Disturbance ...	60·0

During the period of eleven days covered by the photographs only this one group of spots was visible. In this time almost the entire solar surface was under observation.

We see from the above position angles that this region of sun-spots occupied the same line of sight as the apex of the disturbed coronal region. While it is true that we have no means of determining the exact position of the coronal disturbance in the line of sight, attention was called in Bulletin No. 9 to the probability that its origin was near the Sun's limb. As both sun-spot and disturbance are shown to have the same latitude, it can hardly be doubted that this unusual appearance in the corona was in reality immediately above the group of sun-spots and faculæ, and that it had its origin in the same disturbance of the Sun's surface. The long, thread-like prominence to the south, seen projected almost tangentially from the Sun's surface, appears likewise to have emanated from the same group of spots and faculæ.

These observations furnish very strong evidence of the intimate connection of all solar phenomena. Sunspots, faculæ, prominences and corona all seem, in the present case at least, to have had a common origin.

The appearance of this disturbed region in the corona and its undoubted connection with the group of spots on the surface so strongly suggested great activity that an investigation was made as to whether there had been a measurable displacement of any of the coronal masses in this region. The interval of time between photographs of the corona available for this purpose was but little over five minutes, yet if the velocities were large, 50 or 100 miles per second, such motion should be easily detected. The results give no certain indication of motion in the interval. The uncertainties of measurement of these coronal masses is so large, however, that a velocity of 5 or 10 miles per second would not be detected in so short an interval of time. We may conclude that the velocity across the line of sight was less than 20 miles per second

The interval of one and one-half hours between the times of the eclipse in Mauritius and Padang should render a comparison of negatives secured at these two stations valuable in this connection.

C. D. Perrine.

THE USE OF HAND TELESCOPES IN ASTRONOMY.

By Cecil Jackson.

III.—THE PLANETS.

Mercury.—This planet is practically beyond the reach of very small telescopes. It appears very small even in a 3-inch telescope. The crescent phase might be glimpsed with a power of 80 on a 2-inch instrument.

Venus.—The crescent phase of this planet may be distinctly seen with a power of 30 or 40 on a 1½ or 2-inch telescope. A pocket telescope with a good magnifying power will just show the crescent, especially if the lens next but one to the eye-end be removed. Owing partly to the great brightness of the planet, and partly to its great distance from the earth at the time of the gibbous phase, this latter phase is not well seen in hand telescopes of ordinary power. With a power of 80 this phase would be visible.

Mars.—The marking of this planet will barely be distinguished in a 2-inch hand telescope, even if the instrument is fitted with an astronomical eye-piece, but its small red disc may be distinguished with a power of 30 or 40, and may be seen with a pocket telescope at a favourable opposition of the planet.

Jupiter.—The disc of this planet may be seen at any time when the planet is visible. The four chief satellites discovered by Galileo in 1610, are readily observed in a 1½-inch telescope. The smallest satellite was not discovered till 1892 at the Lick Observatory by Prof. Barnard, and is visible only in two or three of the largest telescopes in the world.

Fig. 7 is a sketch of Jupiter, as seen with my 1⅝-inch telescope at about 8h. 56m. p.m., July 13, 1899. An astronomical eye-piece was used. Jupiter's belts are not conspicuous in a 1½-inch telescope. The satellites form sometimes a striking group. Two seen close together make a pleasing view.

Fig. 7.

Fig. 8.

Saturn.—A power of 30 diameters will show the wonderful ring system surrounding this planet. The crape ring, however, cannot be seen with any telescope so small as two inches in aperture. The two bright rings will be seen as one. A 2-inch instrument is too small to show the division between them.

Fig. 8 gives an idea of the appearance of Saturn, as seen with the ring widely open, on Aug. 30, 1899. Power 30 on the 1⅝-inch telescope was used in making this sketch. With a pocket telescope, Saturn simply appears as an oval disc, the dark sky between the ball and the ring being invisible, except perhaps with an extra high power on the instrument. Uranus and Neptune are, for all practical purposes, beyond the reach of even 2-inch telescopes. The disc of Uranus might be just made out with such a glass by comparing it with a small star.

RECENT OBSERVATIONS OF MARS.

By E. M. Antoniadi, f.r.a.s.

The question of objective change on Mars, beyond the obvious formation and dissipation of the polar snows, has long been the battleground of modern areography. For years and years such change was denied, and, indeed, the old observations of surface modifications were too rough to be able to carry conviction. Based, however, on *a priori* considerations, which were not in harmony with experience, the arguments of the unbelievers were destined to fall in the long run, their defenders having departed from the true course of enquiry—induction, based on acute observation.

Change evidently implies, here, as elsewhere, the action of some sort of energy, and, especially, radiant energy; such energy coming either from the planet itself or from the sun. That the planet's crust derives no appreciable quantity of heat from the interior, is amply demonstrated by the presence of snow at the poles. The snow forms, unchecked, in winter, extending down to latitude 60° at least, no tremor from the soil coming to "unlock the molecular embraces" of crystallization. But though enfeebled by distance, the efficiency of solar radiation in melting or vaporizing snow has been observed to be so powerful on Mars, that we should scarcely expect it to have no other effect on the phenomena presented by the planet.

Experience agrees well with this anticipation of seasonal change. Were all the dark areas of the planet to be unfreezing seas, it would, perhaps, be difficult to find how seasonal change would affect their colour. But a few of the most prominent "Maria" (like the Mare Acidalium, for instance) have been observed dark in spring, discoloured in summer, and faint in autumn, thus suggesting change subordinated to the planet's seasons, and due, according to Prof. W. H. Pickering, to some sort of vegetation.

It seems thus highly probable that part of the grey markings of Mars are vast vegetation tracks. Others might be water areas. At any rate, both vegetation and water would present nearly kindred phenomena at the great distance we are viewing the planet.

Now, the detection of delicate detail on Mars is by far the most trying and exhausting of all astronomical observations.

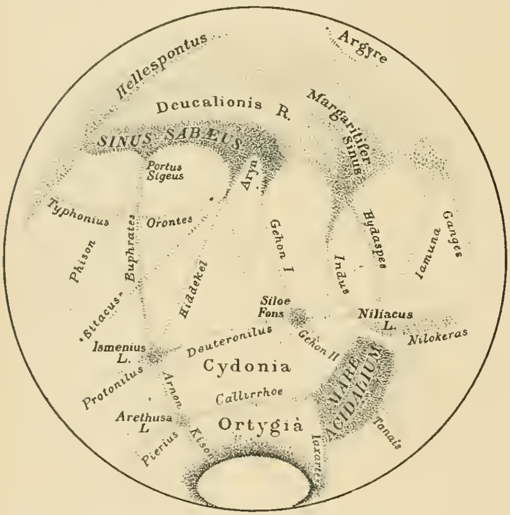


Fig. 1.—Mars in 1900-1901. Longitude of the centre of the disc =0°.

Sustained by an enthusiasm whose reward is an inward approval only, the astronomer keeps his eye to the telescope for hours together, sometimes seeing very little indeed, but recording all fugitive impressions, objective as well as subjective. This is almost transcending ordinary experience and treading into somewhat dangerous ground. An instructive instance of the manner in which illusion creeps into the work of eminent observers is furnished by the observations of Venus made at Flagstaff, in America. "The markings (canals) of Venus," says Mr. Lowell, "are as distinct really as those of the Moon." It would be useless to insist on the fallacy of this statement—a fallacy obvious to the beginner in star gazing. But the remark is exceedingly valuable, as establishing beyond doubt the existence of what might be called *the canaliform illusion*. And, if subjective canals can be seen as harsh as the markings on the Moon, it would not be illogical to believe them to assume all shades of intermediate intensity, beginning with the greatest brightness of planetary discs in order to culminate in the above climax of darkness.

Nothing is easier then, in appearance, with the view of avoiding the canal deadlock, than to take the obvious step,

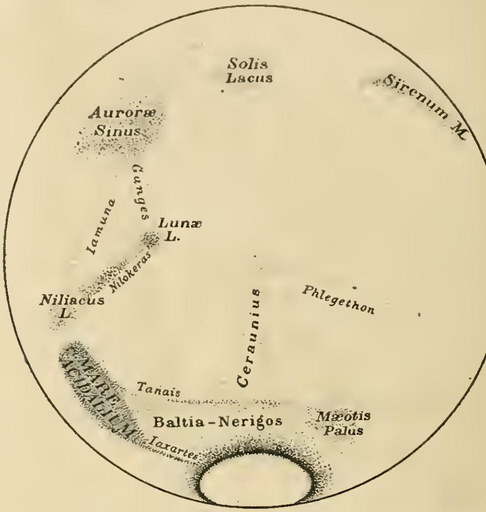


Fig 2.—Mars in 1900-1901. Long. = 90°.

and brand with illusion the whole canal network of Mars, the argument being that imaginary canals have been seen on Mercury, Venus, and the satellites of Jupiter, and that, after all, canal digging could not reasonably be the leading

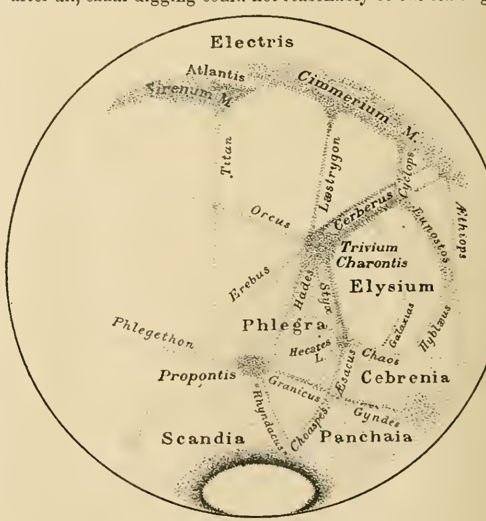


Fig. 3.—Mars in 1900-1901. Long. = 180°.

preoccupation of our neighbours in space. But a more careful examination of the matter will infallibly lead to the fact that, contrary to those of Mars, the canals of

TELESCOPIC APPEARANCE OF THE PLANET MARS

On 1901, February, 10d. 23h. 3m. G. Civil T. Longitude of the centre = 334°. Latitude = −21°·5.

the other worlds have not the self-same positions for different observers. A query of scepticism might be

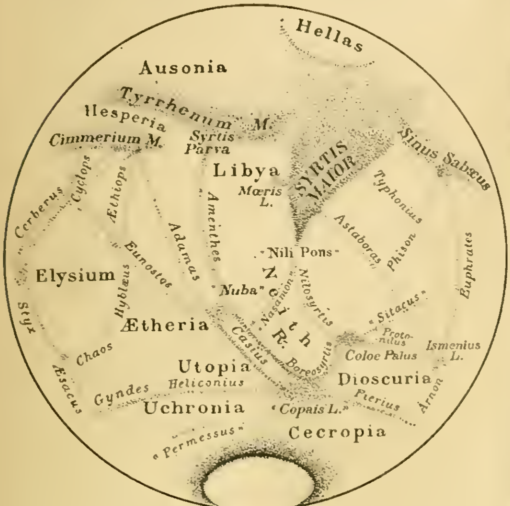


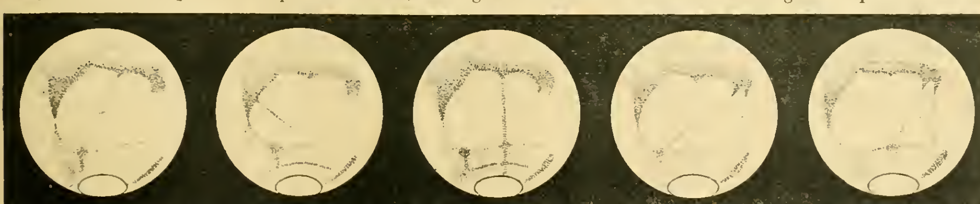
FIG. 4.—Mars in 1900-1901. Long. = 270°.

attached to a fugitive, non-recurring impression of a dark line splitting a planetary disc. But if an analogous impression occur, again and again, on the same night, and always at the same point of the planet's surface, shifting along with the rotational displacement, it is perfectly logical to infer that the appearance, no matter how simplified by distance and exiguity, and the laws of delicate vision, rests on a substratum of objective reality. And such is precisely the case of the Martian canals.

In a valuable paper written in KNOWLEDGE for 1894, Mr. E. W. Maunder pointed out what he thought was the reason of the visibility of the Martian canals, namely, that different dark points on the planet's surface, too small to be appreciated individually, produced on the retina the idea of diffused lines. Mr. Maunder predicted then that the next discovery on Mars would be that of small dots, or "lakes." The forecast has been since verified to the letter. In 1895, we had Mr. Lowell's numerous dots or "oases," while last year my friend, M. G. Millochau, the able and industrious astronomer of the Meudon Observatory, using the largest refractor in Europe, the noble 33-inch object-glass of the Brothers Henry, wrote:—"I have seen the canals like some sort of chaplet of small, dark, irregular masses."

The resolution of the canals into their components is evidently reserved to powerful instruments only.

Another significant fact about the canals is that many of them form the boundaries of half-tones. This discovery, due to the late Mr. Green, has been verified in 1899 by the Rev. P. H. Kempthorne, of Wellington College, and, subsequently, by a very great number of first-class observers. As will be gathered by an inspection of Figs. 1 to 4, embracing the whole of the writer's impressions in 1900-1901, a considerable part of the planet's northern hemisphere was covered with a delicate shading, whose southern edge was limited by the canals "Nasamon," Nilosyrtis, Protonilus, Deuteronilus, Gehon II., Tanais, Erebus, Styx, Chaos, Hyblæus, and Eunostos. The intensity of this half-tone was far from uniform, being lightest in Cydonia, great in Phlegra, between the Hades and Styx, and very great in Utopia, where it formed a "marsh," to which was given the name of "Copais Lacus." Generally, the canals are very difficult objects, being perceptible by rare glimpses only. The appearance of Mars on the accompanying Plate* is the summation of the successive fugitive impressions shown in Fig. 5. It must also be borne in mind that, in spite of the exiguity of the disc, the eye cannot see sharply, at a



22h. 8m. Duration = 2s. | 22h. 21m. Duration = ½s. | 22h. 34m. Duration = ½s. | 22h. 46m. Duration = 1s. | 22h. 51m. Duration = ¼s.

FIG. 5.—Mars on the Evening of 1901 February 10, showing the Successive Impressions on which the annexed Plate is based.

1894. | 1898-1899. | 1900-1901. (Scriven Bolton.) | (E. Atkins.)

FIG. 6.—The Cyclops-Cerberus Region of Mars from 1894 to 1901.

* The canals have come out too narrow on this picture. This is due to the fact that their edges were so light on my original drawing that they could not sufficiently impress themselves on the reproduction.

given moment, *all* the details of the planet's configuration, but only a very small fraction of them. A careful naked-eye study of the full moon leads to the same impression.

During the last apparition of Mars the Cerberus was fully as dark as the Mare Cimmerium. It was, moreover, seen double at Juvisy, the duplication being independently confirmed by two skilful English amateur observers, Mr. Scriven Bolton, of Leeds, and Mr. Ernest Attkins, of Highgate (Fig. 6). Another double canal was the Casius in 1900-1901.

A comparison of these drawings with Prof. Schiaparelli's charts confirms the accuracy of the Milan designs, though departing from them in many particulars. Leaving aside the absence of delicate shading in Schiaparelli's representations of the planet's north hemisphere, which might be of a physiological origin, we might readily attribute the most striking discrepancies to actual change on the Martian surface. As far as minor detail is concerned, the planet is no longer what it appeared to be from 1877 to 1890, the chief changes during the last decade being :—

(*a*) The unaccountable disappearance of Aonius Sinus since the 1892 opposition ;

(*b*) The fading of the canal, once the darkest, Nilosyrtis ;

(*c*) The bridging of Syrtis Major by "Nili Pons" ;

(*d*) The formation of the canal "Nasamon" ;

(*e*) The great faintness of the Cerberus in 1894 (Fig 6), and its extraordinary darkness during the apparitions of 1898-1899 and 1900-1901 ;

(*f*) The increased darkness of the canals Amenthes and Nilokeras ; and

(*g*) The darkness of Phlegra, Cebrenia, Ætheria and Utopia, together with the formation of the "Copais Lacus."

Some of these metamorphoses occurring, as they do, in the equinoctial zone of Mars, are hard to ascribe to mere seasonal change. Nor can it be argued that the changes lie within observational errors. The possible occasional formation of cloud cannot help us any better here, inasmuch as the disappearance of dark markings (such as the Aonius Sinus) is not attended by a corresponding whitening of the regions in question. Clouds condensing on Mars ought to appear as white spots, hence differently coloured from the yellow continents, as well as from the grey "Maria." And thus is it that the majority of changes occurring on this little planet will remain long, if not ever, one of the greatest enigmas which it was given us to witness in the universe.

Letters.

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

THE GREAT SUN-PILLAR OF MARCH 6.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—A very fine example of the sun-pillar was visible on Thursday, March 6th, at St. Leonards-on-Sea ; and as the phenomenon is somewhat uncommon, a short description of it may be of interest to your readers.

The day had been remarkably fine and clear for the time of year, and towards evening the western horizon became hazy. About ten minutes before sunset, a faint red glow was noticeable above the sun's disc ; but it was not until the sun had disappeared behind the dark outline of the South Downs that the phenomenon became strikingly beautiful. The sunset was a characteristic one ; small red clouds standing out sharply against a clear greenish-blue sky. By 6 o'clock the yellow pillar had become very clearly defined ; it extended upwards for a considerable distance from the horizon, and was brightly luminous throughout its entire length. As the sunset colours deepened to purple and orange, the band appeared to increase in brilliancy.

But the most remarkable feature of the phenomenon was to follow, for the pillar gradually changed in hue from yellow to deep rose, as the sunset tints had previously done. And finally it appeared like a gigantic ruby candle flame, showing up brightly from behind a long grey cloud-bank. It was still traceable at 6.25, or about forty minutes after the sun had set.

Another sun-pillar was visible at St. Leonards one evening last June, appearing as a bright perpendicular beam of yellow light springing from the setting sun But the instance recorded above differed from it, both in the gradually deepening colours of the pillar, and also in the fact that the pillar itself was always of a different hue to that of the background of sky on which it was projected. Apart from its beauty, the phenomenon of March 6th was so wonderfully distinct, and of such long duration, that it must have attracted the attention of many observers.

Any of your readers who may be interested in the formation of sun-pillars by horizontal reflection, will find an explanation of the phenomenon in an illustrated article by the Rev. S. Barber, on p. 132 of the Knowledge Volume for 1895.

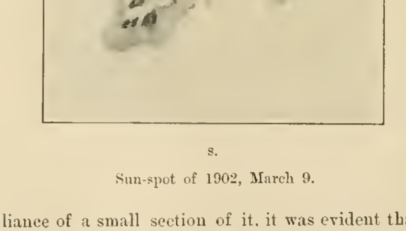
S. R. Stawell Brown, B.A.

St. John's College, Oxford,
March 12th, 1902.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Shortly after sunset last night my attention was called to a remarkable sight. From the point upon the horizon where the sun had disappeared, a glorious parallel-sided shaft of brilliant rose-red light traced its length (some 45° or more) upwards towards the zenith, upon the clear background of twilight sky.

From the fact that a belt of thin grey cloud veiled the



Sun-spot of 1902, March 9.

brilliance of a small section of it, it was evident that the shaft was beyond and independent of the cloud.

It was under constant observation from 5.55 p.m., when it was first "timed," until it disappeared below the horizon at 6.28 p.m. It sank all the while slowly and steadily from view, preserving its features of colour, form, and brilliance apparently unchanged to the last.

The width of the shaft I judged to be between 1° and 2°, and it appeared to be rounded off at its summit in a somewhat brush-like formation. So strong was the impression it gave me of being a true solar appendage that I could not help wondering if we were, in fact, enjoying a vision of the "Corona," coloured by diffraction in the earth's atmosphere. Later in the evening there was a faint but unmistakable appearance of the Zodiacal Light.

It would be interesting to know if any record was obtained at Greenwich Observatory or elsewhere, on the 6th inst., of any unusual terrestrial-magnetic activity, or of any solar outbursts.

The magnificent group of sun-spots, of which the above sketch was made on the 9th inst., was nearing the central meridian at the time.

A large number of people in Bradfield observed the phenomenon independently; and all agree as to the form and colour of the light, and also as to its unwavering persistence till the moment of its disappearance below the horizon.

The Red House, Bradfield, Berks, 1902, March 7. — CATHARINE O. STEVENS.

[Two groups of spots, both in high northern latitude, were crossing the disc of the sun on March 6. The preceding group was on the central meridian on March 3; the following group, which Miss Stevens has represented, and which was much the larger of the two, crossed the central meridian at daybreak on March 8. There was a very slight disturbance of the magnets on March 11 at 4 p.m.—E. WALTER MAUNDER.]

Conducted by W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U.

CHANGES OF PLUMAGE IN THE MALLARD (*Anas boscas*).—At the meeting of the British Ornithologists' Club, held on the 19th February, 1902, Mr. J. G. Millais exhibited a very beautiful series of specimens of the Mallard, to illustrate the changes of plumage undergone by this species from the first appearance of the feathers to the fully adult dress, and during the remarkable "eclipse" of the adult male. In addition to a large series of skins, a number of plates, which will illustrate his forthcoming work, were also exhibited. Many of the facts brought forward by the author appear to be new, and are certainly of very great importance to the student of moulting birds. They promise, furthermore, to throw considerable light on the vexed question of the nature of colour changes in fully developed feathers.

A PUZZLING PARROT.—At the meeting of the Ornithologists' Club, above referred to, the Hon. Walter Rothschild exhibited a very remarkable variety of *Eclectus roratus*. It had the back, right wing and right side of the head and neck maroon-crimson, most of the feathers edged with green, the left wing and left side green with maroon-red bases to the feathers, whilst the feathers of the breast and abdomen were indiscriminately coloured green and purplish blue. In spite of the mixture of colours the general appearance was red on the right and green on the left side of the bird. It was suggested that this peculiar coloration was to be attributed, either to hermaphroditism or to one-sided erythrism. Unfortunately only the skin of the bird came into Mr. Rothschild's possession, and no examination of the reproductive organs appears to have been made. This skin had been brought to Makassar by Mr. Van Duvienbode's traders, and was said to have been obtained in Northern Halmahéra.

PEACOCK AND GUINEA-FOWL HYBRID.—*The Field*, February 15th, contains a short account, together with a photograph, of a hybrid between a White Peacock and a Guinea-hen, now in the possession of the Hon. Walter Rothschild. "The head and neck are incontrovertible evidence of the peacock sire, whose white plumage is shown in the primarie of the wings. The rest of the plumage is that of the female parent, the guinea-fowl." This is an exceedingly interesting cross, and so far, we believe, the first of its kind on record.

Allen's Gallinale (Porphyriola alleni) (The Field, February 8th, 1902).—On New Year's day a specimen of this rare bird was captured alive at sea on a fishing boat off Hopton, near Great Yarmouth. It is an African species, and although it has occurred more than once in Italy and Sicily, it does not seem to have been recorded for Great Britain before.

A White Snipe (Gallinago cœlestis) (The Field, March 1st, 1902).—A white variety of this species has recently been shot in Ireland—near Killeshandra.

The Wall-Creeper (Tichodroma muraria).—Ornithologists may be glad to know that a Wall-Creeper is now to be seen in the insect house at the Zoological Gardens, London, and appears to be thriving. This is the first time that this bird has been exhibited in the Society's Gardens.

All contributions to the column, either in the way of notes or photographs, should be forwarded to W. P. PYCRAFT, *at the Natural History Museum, Cromwell Road, London, S.W.*

NOTES.

ASTRONOMICAL.—A new determination of the effective temperature of the sun which has been made by Dr. W. E. Wilson, F.R.S., gives the value 6863° C. (absolute), after making allowances for absorption in the atmospheres of both earth and sun. By the expression "effective temperature" is meant that uniform temperature which the sun would have to possess if it had an emissive power equal to unity, at the same time giving out the same amount of radiant energy as at present.

An interesting feature of the solar eclipse of May 18th, 1901, was a disturbance of the coronal structure in the neighbourhood of a prominence. Mr. Perrine, of the Lick Observatory, has recently examined photographs of the sun taken at Dehra Dûn on several days just before and after the eclipse, and it results that a spot which came into view on the 19th was, at the time of eclipse, on the further side of the sun, and about 4° from the limb. The spot was surrounded by faculæ, and it is considered that the spot, faculæ, prominence, and coronal disturbance had probably a common origin. That the action which produces a spot may exert an influence on the coronal streamers in its immediate neighbourhood seems sufficiently probable, but it does not follow that the streamers owe their origin to the same disturbances which cause the appearance of spots.—A. F.

Botanical.—A new botanical publication has been started in Ceylon under the title of *Annals of the Royal Botanic Gardens, Peradeniya*, edited by the Director of the Gardens, Mr. J. C. Willis. Two parts have now appeared. In the first, Mr. Willis gives an interesting history of the Ceylon Botanic Gardens, and deals with them in reference to the many advantages which they afford as a centre for botanical study. The later part contains, among other papers, "The Botany of the Maldive Islands," by Messrs. J. C. Willis and J. S. Gardiner. The Maldives are a large archipelago of coral islands lying in the Indian Ocean, between 7·6° N. and 0·42° S. lat., and between 72·33° and 73·44° E. long. The islands have a flora of about 284 species of flowering plants and ferns, about 197 of which are cultivated species or weeds. One of the most interesting plants is *Cladium jamaicense* (Cyperaceæ) which, though widely distributed, is not known from India or Ceylon except from high elevations in Kashmir. It occurs in Mauritius.

The early history of botany and the illustration of botanical books, as represented in the celebrated *Herbarius* and *Hortus Sanitatis*, is dealt with in Dr. J. F. Payne's admirable treatise, which appears in the *Transactions of the Bibliographical Society* for last year. The *Herbarius* was the first book published in Germany containing woodcuts of plants. The first dated edition appeared at Mainz in 1484, and this, as far as can be ascertained now, was really the earliest date at which the work was published. Several undated editions exist, and one, printed in the Low Countries, has been considered by some bibliographers to have priority over the Mainz edition of 1484. The *Hortus Sanitatis*, or *Herbarius zu Teutsch*, was also printed at Mainz, and bears the date "28th March, 1485." It was evidently issued by the printer of the *Herbarius*, Peter Schöffer, and, appearing in the following year, has been regarded as a second edition of that work in German. Dr. Payne, however, shows the improbability of this. The *Hortus Sanitatis* was published early in 1485, and must have been in preparation for some years before the *Herbarius* was printed.

In the *Bulletin de la Société Botanique de France*, 1901, p. 107, Monsieur Bois gives an account of a new Labiate which promises to be of considerable importance on account of the edible tubers which it freely produces. This plant, known to the natives as Ousounifing, and described as *Ptectranthus Coppini* by the late Prof. Cornu, is found in the Soudan. Besides this species, several Labiates belonging to the genera *Plectranthus* and *Coleus*, each more or less valuable economically, are mentioned. In a later paper, which appeared in the *Bulletin du Muséum d'Histoire Naturelle* (Paris), 1901, Monsieur Bois refers to the introduction into the Jardin des Plantes, Paris, of *Phyllactis pratensis*, which also has edible tuberous roots. This plant belongs to the Valerianaceæ, and has properties similar to those of the Valerian. Its tubers are straw-coloured, twenty-seven millimetres long, and nearly the same in diameter, and emit a strong odour. The natives of Mexico, whence the tubers were received eat them when cooked as a remedy for liver complaints.—S.A.S.

Zoological.—That much still remains to be done before we are fully acquainted with even the larger mammals of the world is evident by the announcement made at a recent meeting of the Zoological Society of the existence of a previously unrecognised species of elk in Siberia. This elk, of which a skull with antlers and a detached pair of antlers were exhibited, differs from the elks of Norway and North America (which form merely local varieties of a single species) by the absence of any distinct expansion, or "palmation," of the beam of the antlers, and the small number and large size of the tines in which they terminate. It was proposed to call this very distinct species of elk *Alces bedfordiæ*, in honour of the Duchess of Bedford. Unfortunately the precise locality whence the specimens came is not definitely known, although it is believed to be eastward of the Altai. The specimens exhibited to the Society were obtained by Rowland Ward, Limited, of Piccadilly; and the same firm have subsequently received five other pairs of antlers. No less than five out of these seven specimens are now in the museum of Mr. Walter Rothschild at Tring. It may be added that in a recent issue of the *Bulletin* of the American Museum, Mr. E. W. Nelson announces the discovery of a new species of "elk" in Arizona. The animal in question is, however, a wapiti, and probably a local race rather than a species. This American misuse of terms is much to be deprecated.

In their *Report* for 1901 the Council of the Royal Zoological Society of Ireland announces that the menagerie at Dublin has never contained so large or so fine a collection of lions as at present. There are seven cubs approaching maturity, five of which are exhibited in one den. The *Report* contains an excellent photograph of three of the group.

The subject of lions reminds us that, in a description of fossil mammals from Colorado, published in the *Memoirs* of the American Museum, Mr. W. D. Matthew discusses the manner in which the great extinct sabre-toothed tigers (or lions) of the genus *Machærodus* used their enormous upper canine teeth. These formidable tusks (in some cases nine or ten inches in length) were so long that if the animal opened its mouth only to the same extent as a modern tiger they would obviously block the gape and be worse than useless. And it has accordingly been suggested that these animals attacked with their jaws closed, stabbing with the projecting extremities of the upper tusks. It is obvious, however, that such a mode of attack would discount whatever advantage might be gained by the abnormal length of the tusks, while it would apparently tend to injure the lower jaw. Moreover, as the author points out, it is difficult to conceive when this mode of biting could have been adopted, as there must have been a time when the tusks, although too long for use in the ordinary manner, would not have projected beyond the border of the lower jaw. It has long been known that in the mode of articulation of the lower jaw to the skull the sabre-tooths differed markedly from ordinary cats, and this leads Mr. Matthew to suggest that when attacking they dropped the lower jaw vertically, and thus left the entire length of the upper tusks fully exposed. Obviously, in such a position, the creature could not bite in the ordinary manner, and the author suggests that the sabre-tooths killed their prey (which probably consisted of short-necked and thick-skinned primitive herbivora) by stabbing or ripping them in positions where large arteries could easily be reached. It is pointed out that this mode of attack is in harmony with the weakness of the lower jaw in the sabre-tooths and the strength of their fore-limbs, which acted as fulcrums. Although the explanation seems at first sight strange and almost incredible, it seems to suit the peculiar circumstances of the case better than any other yet offered.

At a meeting of the Zoological Society of London, held on March 4th, Dr. H. L. Jameson discussed the origin of pearls, especially those produced by the common mussel. It has long been a matter of uncertainty how these concretions were first started, but the author showed that they are primarily due to the presence of the larva of a parasite allied to the liver-fluke. This larva incysts itself in the mantle of the mussel, where, if it die, it becomes calcified, and thus forms the nucleus of a pearl. The parasite commences its life in the common cockle and the bivalve known as Tapes, and apparently concludes it in the digestive tract of certain ducks, such as the scoter and eider. Similar parasites appear to be the cause of pearls in certain of the pearl-oysters; and the author holds out hopes that by means of these parasites the production of pearls may be artificially induced.

The menagerie in the Regent's Park has recently received two important additions, one a young specimen of the snow-leopard (*Felis uncia*) and the other a Himalayan or long-tailed panda (*Ælurus fulgens*). Of the latter animal only two examples have been previously exhibited, one in 1869 and the other in 1876. Till recently the Himalayan panda was considered to be the only Old World representative of the raccoons, but, as already noticed in these columns, Prof. Ray Lankester has shown that *Æluropus melanolecus* of Tibet is a member of the same group.

The Royal Society has issued its sixth series of Reports to the Malaria Committee, the present fasciculus dealing with the relation of malarial endemicity to species of *Anopheles*, with certain points in the biology of the Bengal representatives of the latter, and with the relation between enlargement of the spleen and parasitic infection. A second contribution in connection with the subject appears in the *Proceedings* of the Society, where Mr. F. V. Theobald writes on the gnats and mosquitoes of India, and describes certain new species of *Anopheles*. He remarks that since only certain *species* of the latter genus are malaria-producers, it is quite possible that certain kinds of *Culex* may be capable of communicating the disease.

Notices of Books.

"Lamarck, the Founder of Evolution, his Life and Work." By Alpheus S. Packard, M.D., LL.D. (Longmans, Green & Co., New York.) 9s. net. This book possesses a variety of interest. The life of Lamarck did not follow an entirely even and commonplace tenor. Born in 1744, he began practical life as a soldier, and in the field showed an obstinate courage and sense of duty. As a man of science he had to support himself and a large family on a meagre income. In 1793 he obtained a botanical appointment at the Natural History Museum at Paris. Till the age of forty-nine he was a systematic botanist; but when a professor of invertebrate zoology was wanted, he volunteered to take that class of unknown or half-known forms, as it then was, under his care. In the *etat* of persons attached to the National Museum of Natural History he is thus described:—"Lamarck, ——, fifty years old: married for the second time: wife enciente: six children: professor of zoology, of insects, of worms, and microscopic animals." Thus at an age when many men are thinking of giving up serious work, and taking life easily, Lamarck began labours greater than any he had undertaken hitherto, though from his youth up he had been a man of strenuous energy. For some years previous to his death he was totally blind, and had it not been for the devotion of his daughter, the last volume of his *animaux sans vertèbres*, and part of the sixth, would never have seen the light. All this is excellently told by Prof. Packard. We now proceed to Prof. Packard's estimate of Lamarck as a man of science. There can be no doubt that Lamarck did valuable work as a systematist, both in botany and zoology. He had a good eye for generic points. But his reputation depends upon his theories, and we must try to estimate their value. His speculations in chemistry and geology were crude, but he was then travelling beyond his own *métier*. It is upon his theory of evolution that we must focus attention. It was much that he stoutly maintained that evolution had somehow taken place, at a time when many men of science still clung to the doctrine of fixity of species. But his explanation of the process by which evolution was brought about—new organs by willing, the further development of existing organs by exercise—originated in an ignorance of facts. "Behold," he says, "in our stout and clumsy horses, habituated to draw heavy loads, and which constitute a special race by always being kept together—behold, I say, the difference in their form compared with those of English horses, which are all slender with long necks, *because for a long period they have been trained to run swiftly*" (the italics are ours). Here then is the origin of the Lamarckian hypothesis. He imagines that the breed of racehorses has been produced by a system of training. He has never heard of selection. The fact is that he was a museum man, and was thus quite in the dark with regard to a great deal that went on out of doors. Evidently it never occurred to him to doubt that acquired characteristics are inherited. The great defect of his *Philosophie zoologique* is that it is mere speculation without evidence. Darwin appealed to the great results produced by artificial selection. Lamarck went for evidence to the same quarter, but failed to get hold of the facts. His *Philosophie* must be treated as a purely speculative treatise on a level with the lucubrations of Erasmus Darwin, and others. Charles Darwin produced much evidence, though, of course, no positive proof, and his work, therefore, stands on an entirely different footing. It is natural that a biographer of Lamarck should mistake the little back eddy in the direction of Lamarckism for the main current of scientific thought. Nevertheless, Lamarck is a very interesting figure. He did much solid work, and he speculated in a bold untrammelled way that could not fail to awaken men's interest in the subject.

"Britain and the British Seas." By H. J. Mackinder, M.A., Reader in Geography in the University of Oxford. (London: William Heinemann. 1902.) Pp. xvi. and 378.—This is not like other books on geographical subjects, and it is encouraging to see such modern and scientific treatment of a long neglected study coming from one of the ancient universities. If this volume gives a fair sample of the teaching of geography in Oxford, undergraduates who take advantage of their opportunities are much to be congratulated. The style of the book no doubt suggests the platform rather than the study; there is a tendency towards great swelling words and a sonorous roll in the sentences that would appeal, we think, more powerfully to the ear than to the eye. However, the subject is treated in a large way and a certain grandeur of language is not inappropriate. The idea is to describe the great features of the country and not to bother about details. Nothing is touched upon which has not a special significance, and not only are the features of the land and sea described, but a point is made of tracing their origin from the earliest geological period. The evolution of the British Islands is treated to some extent in the manner of Mr. Jukes-Browne's "Building of the British Isles," only instead of tracing the history stage by stage back into the past, Mr. Mackinder begins with the earliest times and traces it down to the present. Once the present surface of the land has been reached by the carving out of their valleys by consequent, subsequent and obsequent rivers, we are shown how the relation of the British Isles to the Continent has affected the climate, vegetation, etc., and how the various streams of immigration and conquest have produced the present political condition of the country. The racial, historical, strategic and economic geography of the Islands are treated in a series of chapters, and it is interesting to see how geology is brought in to explain facts, the distribution of which is being described. Special chapters are devoted to England, Scotland, and Ireland, but they are far too short in our opinion. Some of the geology could have been spared to make room for a fuller description of the regions of the country. Wales ought to have had a chapter to itself, and the sub-division of England might have been carried further. The two chapters devoted to England are entitled "Metropolitan England" and "Industrial England," and the former, one is naturally surprised to find, includes all England south and east of a line drawn from the Severn to the Wash. It would have been more useful to have restricted the term "Metropolitan England" to the country within say 30 miles of London, and the seaside suburbs like Brighton, and to have treated the rest of the south-east as "Rural England," while Cornwall might have been usefully considered with Wales. The statements are not always quite accurate. Thus we read "To-day there are in Great Britain more than twenty-six million sheep or approximately one sheep for each human being" (p. 318.) If "to-day" means 1900, for we suppose the passage was written before the census report of last year appeared, we find in the "Statesman's Year Book" for 1901, that the number of sheep in Great Britain was 26,592,226 and the estimated population 36,405,900, which seems to show that "approximately" is held to mean "not very near," since 9,913,674 people or 25 per cent. of the population must remain sheepless. But a little looseness in statistics does not affect the purpose of the book, which is to show how the present condition of the British people is the outcome of causes which have been at work since the first changes in the solidifying crust of the Earth.

"A TEXT-BOOK OF ZOOLOGY." By G. P. Mudge, A.R.C.SC., F.Z.S., &c (London: Edwin Arnold. 1901). 7s. 6d.—The number of recent text-books of zoology is legion, and every new volume must add to the bewilderment of the student who is just entering into this field of science. To those who find it necessary to make a selection from among the number of these books, Mr. Mudge's little work may be cordially recommended as a most excellent treatise, and one which possesses some distinctly original features. As a laboratory guide it will be most helpful, whilst the introduction and concluding chapters will afford him, in a clear and condensed form, a good insight into the application of the facts derived from the work of the dissecting room. Being essentially a book for juniors, the modern plan has been adopted of selecting a few types of animals easily to be procured and presenting all the principal features of the groups to which they belong.

Dealing in turn with the Vertebrates, Coelomate and Coelenterate Invertebrates, and the Protozoa, Mr. Mudge brings out the essential characteristics of each animal by a comparison of their several systems and organs. The concluding chapters of the book are devoted to the Life-History of the Cockroach and Butterfly, and the Phenomena of Metamorphosis; Karyokinesis, Oogenesis, Spermatogenesis, Heredity and Variation.

The illustrations are numerous, well chosen, and well executed.

BOOKS RECEIVED.

More Tales of the Birds. By W. Warde Fowler. (Macmillan.) Illustrated. 3s. 6d.

Results of Rain, River, and Evaporation Observations made in New South Wales during 1899. By H. C. Russell, B.A., C.M.G., F.R.S. (Department of Public Instruction. Meteorology of New South Wales.) Illustrated. 3s. 6d.

The Nearer East. By D. G. Hogarth, M.A. (Heinemann.) Illustrated.

Comparative Anatomy of Animals. Vol. II. By Gilbert C. Bourne, M.A., D.SC., F.L.S. (Bell.) Illustrated. 4s. 6d.

Eighteenth Annual Report of the Bureau of American Ethnology, 1896-7. By J. W. Powell, Director. Part 2. (Washington: Government Printing Office.)

Primer of Physiology. By Alex. Hill. (Dent.) Illustrated. 1s. net.

Plea for a National Institute of Geography. By J. G. Bartholomew, F.R.S.E., F.R.G.S., with plan and note by Prof. Geddes. (Reprinted from *Scottish Geographical Magazine*, March, 1902.)

Comparison of Photographic and Visual Magnitudes of the New Star in Perseus. By W. H. Robinson. (*Monthly Notices of Royal Astronomical Society*, January, 1902.)

Theoretical Representation leading to General Suggestions bearing on the Ultimate Constitution of Matter and Ether. By John Fraser, Ordnance Survey. (Williams & Norgate.) 1s. 6d.

Tutorial Arithmetic. By W. P. Workman, M.A., B.SC., assisted by R. H. Chope, B.A. (W. B. Clive.) 3s. 6d.

Text-Book of Magnetism and Electricity. By R. Wallace Stewart, D.SC.LOND. (W. B. Clive.) Illustrated. 3s. 6d.

The Foraminifera. By Frederick Chapman, A.L.S., F.R.M.S. (Longmans.) Illustrated. 9s. net.

Arithmetic of Electrical Measurements. By W. R. P. Hobbs, R.N. (Murby.) 1s.

Recent Progress in Practical and Experimental Electricity. By Reginald Fessenden. (Washington: Philosophical Society.)

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

Scientific Roll. No. 4. *Bacteria.* By Alexander Ramsay. 1s.

Smithsonian Institution Origin and History. Vols. I. and II. By Wm. Jones Rhees. (Washington: Government Printing Office.)

ACROSS RUSSIAN LAPLAND IN SEARCH OF BIRDS.

By HARRY F. WITHERBY, F.Z.S., M.B.O.U.

II.—ARCHANGEL, A WONDERFUL MONASTERY, AND THE EFFECTS OF VODKA.

ARCHANGEL has no pleasing memories for my friend or myself, although we remember it well and especially its custom house. When we arrived at Solombala we were immediately assailed by a posse of custom house officials. Our numerous boxes and packages were not only opened and ransacked, but every bottle and parcel in them was minutely examined, and at length our guns, cartridges and camera were carried off in triumph to be re-examined at the custom house at Archangel. Nowhere else in the world is there such a custom house, and unlucky is the man that puts himself into its clutches. After three days of alternate praying to and cursing the officials at this infamous place, we were allowed to take away our guns, cartridges and camera on payment of an extortionate duty. The amount of duty was assessed by weighing the articles, and consequently the sum payable on the cartridges, which were loaded with shot, was double their actual value. But we were more lucky than a friend who sent all his baggage to Archangel beforehand by sea,

Sketch Map to show route from Trondhjem to Archangel, and from Archangel to Kandalax.

and after being delayed at the custom house for a fortnight, was mulct in £50 for duty on old clothes and camp furniture.

Besides its custom house, Archangel has many mosquitoes of a virulent type. The town is thinly spread over an enormous extent of ground, and the roads are all paved with very rough cobbles. The only means of conveyance are droskis or low springless four-wheelers, the drivers of which are usually drunk. The only things that pleased us in Archangel were the hooded crows.* which acted as scavengers and were very numerous and tame, and the roofs of the houses which were of beautifully soft colours. Had it not been for Mr. Henry Cooke, the British Vice-Consul, who gave us most kind help, it is doubtful when we should have escaped, for to go through the custom house and to get away within a week was considered almost a miracle. This feat was only accomplished at the last by a remarkable drive.

The steamer to Lapland sailed only once a week, and so pushed were we for time at the last moment, that to catch it we had to load all our things upon two droskis and drive two miles in twenty minutes. There was no time to fasten on the baggage, and the only thing to be done was for each of us to stand up in his machine and hold on to the bags and boxes tooth and nail. The roughness of the roads and the springlessness of the carts made it by no means a simple task to keep the luggage from falling and at the same time to impress upon the driver that his horse must gallop. Words had no effect on their stolid drivers, and it was only by thumping them whenever we had a free hand to do it, that the necessary pace was maintained. All went well until we were nearing the quay, when a heavy holdall containing all our bedding fell off one of the droskis, but by signs and shouts to a passer-by we induced him to shoulder the holdall and run after us. The steamer was casting off her ropes as we galloped up to her side, and the excitement we caused amongst the crowd of people who were gathered to say farewell to their friends was worth a great deal to see.

An uncomfortable night with berths only five feet six inches long in the small crowded steamer, which rolled and pitched at the slightest provocation, brought us to

Solovetski Monastery.
From a photograph by Mr. F. R. Ratcliff.

the monastery of Solovetski, far famed as one of the holiest places in Russia.

The monastery is very large and very rich, and is surrounded by enormously high and thick granite walls. Within these are many churches and chapels, with white walls and green cupolas, surmounted by gilded crosses, while here and there are great blocks of white, barrack-like houses. Pilgrims, chiefly of the peasant class, journey thither in thousands, and are housed and fed with simple food for three days. No charge is made, but should the pilgrims have sufficient means he is expected to present a donation to the monastery. We were anxious to see some of the plate and vestments, for the richness and rarity of which the monastery is famed, but the churches were so packed with people, all standing, that we were not able to get further than the doorways.

No living thing may be molested within the precincts of the monastery, and it is remarkable that hundreds of herring gulls,† by no means tame birds by nature, have discovered the sanctuary. They positively swarm within the walls, and have their nests in all the courtyards, even on the narrow pathways. Most of them had young ones

The Entrance to Solovetski Monastery.
From a photograph by Mr. F. R. Ratcliff.

at the time of our visit, and it was most amusing to watch the old birds feeding their dark grey fluffy offspring quite unconcernedly whilst hundreds of people were all round them. Indeed, so tame are the birds that they will take food from one's hand, and will not move out of one's way, and should anyone approach too near to the young, the old birds rush up and peck him vigorously. It is certainly extraordinary that these wild birds have been rendered as tame as chickens by the simple expedient of allowing them to do as they pleased without the slightest interference. The herring gulls all leave Solovetski, we were told, after the breeding season, and it is a remarkable fact that the very birds which are so bold inside these high walls, are no tamer than other gulls when met with outside the walls. How they originally discovered the sanctuary, and how many generations were needed before they realized its absolute security, we endeavoured to ascertain, but could get no definite evidence.

At Kem, our next stop, we were delayed for some time loading cargo into small boats, which were "manned" almost entirely by women. In the summer months there are very few men left on the White Sea coast, as all the able-bodied males go north to fish, leaving the women in charge of their homes. From Kem we journeyed to Keret, where there is a large saw mill, and then crossing the Arctic Circle once more, we put in at Kovda, where another saw mill flourishes, and exports much timber to England. At Kovda we were fortunate in obtaining the services of an interpreter, a Russian, Gregori Kokorin by name, who was a tallyman at the mill, and had picked up a little English from the crews of the boats which came there every summer for wood.

The ice and fog had caused such delays that it was not until July 4th that we reached Kandalax, which was

* *Corvus cornix.*

† *Larus argentatus.*

to be the starting point of our journey across the Kola Peninsula. Here we took up quarters in the house of the pilot. The house, which was of wood, consisted of only one good room, which we occupied while the pilot, his wife and family cheerfully retired to the loft, in the roof of which were many holes large enough to admit one's head.

Our room was furnished with a comfortable looking bed, which we tried but soon forsook with many murmurings (the Russian variety being large and exceedingly voracious), and thenceforth spread our blankets on the hard but peaceful floor. Kandalax consists of a hundred or more wooden houses, and its inhabitants, who are Russians, are believed to sustain themselves by fishing, but during our three days' stay almost every man and woman was drunk. Indeed the inhabitants of this place appeared to be utterly degraded by vodka. They found many opportunities for making holiday. The Greek Church, I believe, provides some three or four saints'

A Boat "manned" by Women.
From a photograph by Mr. F. R. Ratcliff.

days a week, and these are regularly used in Kandalax as excuses for drunkenness, while the day on which the weekly steamer arrives is invariably set aside as a day of rejoicing. Moreover, the people were tipsy day and night, and besieged our room at all hours demanding vodka, and when forcibly ejected they stood in a group outside and droned melancholy chants for hours at a time.

However, we found more society in Kandalax than we had expected. Mons. Boudit, a Frenchman, who was engaged in starting a factory for tinning salmon and other fish, and the chief of the telegraph station, entertained us right royally, and gave us much help and advice. Mons. Boudit informed us that the peasants of this country were utterly worthless as workmen, and in consequence he had been compelled to import labour, not only for the erection of his factory and for the canning of the fish, but even for catching the fish.

The country round Kandalax was mainly composed of dense pine forest, which yielded very little in the way of birds, but the islands in the bay were more interesting. On these islands we found a number of different ducks, a few with young ones, but the majority apparently not yet nesting. Perched on a little rock in the middle of the bay we saw a great dark bird with a conspicuous white tail. We knew this must be the white-tailed sea eagle,‡ and we tried hard to approach it, but it watched our boat jealously, and no sooner had we hidden ourselves behind a small island than the great bird rose, and circling ever higher and higher was soon but a speck in the sky. Then just as we were about to land on an island we noticed a pair of Turnstones‖ running anxiously to and fro on a spit of pebbly shore. They were in their lovely breeding plumage of black and rich chestnut with silvery white breasts - a plumage in which they are occasionally seen in Great Britain, both when they prolong their spring visit to us, or come to our shores somewhat earlier than usual in autumn. But it is seldom that we see the Turnstone in Great Britain either in summer or in winter, for it only passes along our shores in its passage between its northern summer home and its southern winter one. Consequently we were delighted to find a pair of these birds in their breeding haunt, and a few minutes after landing on the island we had the good fortune to discover in a nook under a big stone, close to the water's edge, their nest, which was made of grass and feathers, and contained four dark green pear-shaped eggs.

A problem to be decided at Kandalax was as to how many men would be required to transport our baggage to Kola, a distance of some 160 miles. The problem was complicated because we wished to spend some three weeks on the way, and no provisions, except perhaps bread at one place, were obtainable on the route. Consequently it became a question of how many pounds of food a man would eat each day. Had it been winter, when sledges and reindeer could have been used, there would have been no difficulty, but in summer no transport animals are to be had in Russian Lapland. A calculation and much discussion with Gregori ended in the decision that nine men, carrying some 70 or 80 pounds each, would be sufficient to carry the baggage and food.

The next difficulty was to procure these even, but I must first explain that the route we intended to take was a regular one, instituted and upheld by the Russian Government. The route is chiefly beneficial to the inhabitants of the White Sea coast who, being chiefly fishermen, use it to reach the Arctic Ocean in spring, and to return home in autumn when the White Sea is completely frozen in and impassable. During the short northern summer the route is very seldom used, and the interior of the country is almost deserted. At intervals on this route, which is partly over lakes and rivers, and partly overland, are "stations," and by means of orders kindly provided by the Governor of Archangel, we were entitled to the use of the boats on the lakes and rivers, and to the services of two men each as carriers or rowers to be provided at the "stations" at fixed rates. At Kandalax, therefore, we had to obtain four men at the "station," and in addition required five men to act as carriers all the way to Kola. We gave the word out that we wished to hire men to go to Kola, and as only the pick of the inhabitants were sober at the time it was easy to select five of the strongest and most decent young men from the crowd which soon arrived at our door. It was not so easy, however, to fix the terms, and this was only accomplished after great exertion on the part of our interpreter, whose English required almost as much translating as the native tongue. The men were to feed upon rye bread and salt fish, the usual fare of these poor people, and it was soon known round the village that we were in want of these commodities. A stream of old women quickly appeared carrying great round loaves of dark brown bread and baskets full of salt fish. Much of the bread was mouldy, and many fish were badly cured, but after careful selection, followed by long bargaining and much

‡ *Haliaëtus albicilla.*

‖ *Strepsilas interpres.*

weighing and discussion, we were well provisioned with well-cured fish and good bread, the driest we could obtain, since it was lighter and less likely to turn mouldy than when wet

After much packing and weighing the loads for the carriers were apportioned, and we were ready to start. But the four men ordered some hours before at the "station" did not arrive. We visited the place in force and found the house full of drunken men, who would listen to nobody. The chief man's wife being the only sober person in the house, we cautioned her that we should write a protest in the book kept for the purpose, if the men were not produced in one hour. As they did not appear at that time we bombarded the station again, and forcing our way in wrote the protest and said that we should telegraph to the Governor if the men were not forthcoming in another hour. We had no intention of thus disturbing his Excellency, and were much relieved, when four men appeared, to find that the threat had been sufficient. Another hour was wasted by the carriers in wrangling over the weights of their loads, but at last at nine p.m. we started, and were accompanied to the outskirts of the village by the entire population, men, women and children. Scarcely had we shaken the mud of Kandalax from our feet when one of the station men, who reeled suspiciously in his walk, threw down his load and amidst yells of delight from the crowd and shouts of imprecation from us, staggered back to the village. Fearing that other men would desert if we delayed for long so near the village, we called for a volunteer, and a man stepped out from the crowd. We made terms with him, he shouldered the load, and then and there, without the slightest preparation set out for a month's journey.

The path lay at first up hill over rough, stony ground, but our men, notwithstanding their heavy loads, kept up a good pace. The baggage was fastened to a carrier placed on the back and strapped to the shoulders. The carrier was simple and effective. It consisted merely of a piece of supple green wood bent in a loop and crossed by a network of cord. We were fast forgetting the drunken orgie at Kandalax, and the annoyances of the start. Here and there a peep through the dark pines revealed the Neva, whose name is Swift, rushing down to the sea in one continuous boiling rapid. Occasionally the silvery trunk of a birch tree, or a group of bright green larches broke the monotony of the pines, while the rocky ground was thickly clothed with hoary reindeer moss and a thousand small creeping plants. Our binoculars and guns were ready to be levelled on any bird to be seen as we marched ahead of the carriers trudging in single file along the narrow track.

But, alas, our peaceful state was once again to be disturbed. Gregori came panting up to us saying that one of the station men was bad and was getting worse and worse. On turning back we found that the man was desperately tipsy, and it was evident that he had a bottle about him, but we could not discover it. He continually fell down and lay moaning and groaning. Walking behind this wretched man and treating him like a stubborn donkey, we managed to drive him a mile or two, but at length he sank down and refused to budge. As he lay on the ground we caught sight of a bottle sticking out of his trouser pocket. This he refused to give up, so Gregori Kokorin promptly broke it with a stick. The drunkard then proceeded with great deliberation to pick the broken pieces from his pocket, and finding that there was still some precious vodka left in the bottom of the bottle, he would have drunk it had I not kicked it out of his hands. At that he burst into sobs, and getting up he threw down his load and staggered off into the woods. This man was a type of the grasping drink-sodden Russian peasant, no uncommon class in the part of the country we visited, and when afterwards we found that he was the chief man at a station further on, we wrote down his character in the book for the benefit of the officials who employed him.

One great advantage of the perpetual daylight of the north is that one can sleep and eat just when it is most convenient and necessary. On the first day, or rather night, of travelling we raised our tent and turned in to our sleeping bags at four o'clock in the morning and were soon dreaming, not of drunken obstreperous men, but of all the charming birds we might be destined to discover in the country that lay before us.

PRESERVING AND MOUNTING ROTIFERA.

By CHARLES F. ROUSSELET, *Curator, R.M.S.*

FOR killing and fixing several fluids are suitable, namely, $\frac{1}{4}$ per cent. osmic acid, or Flemming's chromo-aceto-osmic fluid, or Hermann's platino-aceto-osmic mixture. On the whole, I now prefer the last-named, which gives a finer fixation of the cellular elements of the tissues and does not stain them so much. It may be explained that the term "*fixing*" implies rapid killing and at the same time hardening of the tisues to such an extent as to render them unalterable by washing and subsequent treatment with preserving fluids. Proper fixation is very essential, as no good preservation can be obtained without it.

When the Rotifers are narcotised and ready for killing, a single drop of one of the above fixatives is added, and mixed with the water in the watch glass. A few minutes is sufficient for fixing small creatures like these, and then they must be removed again by means of the pipette to several changes of clean water to get rid of the acid, otherwise they will become more or less blackened. When dealing with marine Rotifers, sea-water must be used for washing out, as the difference in density between fresh and sea water is sufficient to cause swelling by osmosis, and the consequent spoiling of the specimen. After thorough washing, the Rotifers are transferred to a preserving fluid, the density of which does not materially differ from that of water. The best preserving fluid found so far is a $2\frac{1}{2}\%$ solution of formalin, which is made by mixing $2\frac{1}{2}$ c.c. of the commercial 40 % formaldehyde with $37\frac{1}{2}$ c.c. of water, and then filtering.

The above are general directions according to which the great majority of Rotifers can be preserved. When under the narcotic, the animals must be watched until it is seen that they can swim but feebly, when, as a rule, they will be ready for killing. If they contract and do not expand again, it is a proof that the narcotic used is too strong, and it must be further diluted. The whole method undoubtedly requires great care and is a delicate operation, which must be performed under some kind of dissecting microscope, but by following the directions here given, and with some perseverance, any one can learn to prepare a large number of species of Rotifers. I would advise that a beginning should be made with some such forms as *Brachionus*, *Anuræa Synchæta*, *Asplanchna*, *Hydatina*, *Triarthra* and *Polyarthra*, which are easy, and moreover occur, and can, as a rule, be collected in large numbers A few genera, however, are exceptionally difficult. These are *Stephanoceros*, *Floscules*, *Philodina*, *Rotifer* and *Adineta*, and it will be better to leave these until considerable experience in dealing with the others has been acquired.

It will have been noticed that the Rotifers must always remain submerged in a watery fluid, and be transferred in a drop by means of the pipette. Fluids of lesser density than water, such as alcohol, as well as fluids of greater density, such as glycerine, are unsuitable because they set up strong diffusion-currents by osmosis, which cause the animals either to swell or to shrivel up completely.

Some species of Rotifers, such as *Triarthra*, *Polyarthra*, *Pedalion*, *Mastigocerca*, etc., have an outer surface which is strongly water-repellent, and when these come in contact with the surface film of the fluid even for an instant, it is most difficult to submerge them again, and as a rule they are lost or spoiled.

Having then successfully narcotised, killed and fixed the Rotifers fully extended, and finally transferred them into 2½ per cent. formalin, the animals may be kept in little bottles, or mounted in the same fluid on micro slides, either in excavated cells or shallow cement cells.

To mount on a slide, place a drop of the formalin solution in the cell, then transfer the prepared Rotifers into this drop with the pipette and examine under the dissecting microscope to see that no particle of foreign matter has been introduced. Then place another drop of the fluid on the slide by the side of the cell and lower the cleaned cover-glass on that drop, then push the cover cautiously and gradually over the cavity. The superabundant fluid is removed with blotting paper, and the slide closed by tipping damar-gold size cement all round the edge with a fine brush.

The permanent closing of these cells has been a matter of very considerable difficulty. As the result of the experience gained I recommend to close the cells first with a coat of a varnish consisting of two-thirds damar in benzole and one-third gold size, then two coats of pure shellac dissolved in alcohol, and finally four or five coats of pure gold size, with an interval always of twenty-four hours for each coat.

By the method described above I have in the course of the last ten years made a collection of over five hundred slides containing nearly three hundred different species of Rotifers, probably the only collection of the kind in existence, which is of the greatest use for the identification of species and for the general study of this interesting class.

Conducted by M. I. Cross.

Pond-life Collecting in April.—All species of Infusoria and Rotifera mentioned as occurring in March are likely to become more abundant in April, which is one of the best months for collecting. The ponds are full of water, whilst they have become approachable, and Daphnias and Cyclops have not yet crowded the Rotifers out, as sometimes occurs later on. *Volvox globator* may be looked for together with the little parasitic Rotifer, *Proales parasitica*, inside the green spheres.

Of larger Infusoria, *Bursaria truncatella*, *Choenia teres*, *Amphileptus gigas* and *flagellatus* will be found, and, of course, crowds of *Euglena viridis*.

Of Rotifera, *Synchaeta pectinata* will be abundant, and *Asplanchna priodonta* and *brightwelli* will have made their appearance in larger lakes and canals; also *Brachionus pala*, *quadratus*, and *bakeri*; *Euchlanis triquetra* and *hyalina*, *Triarthra longiseta*, *Diaschiza semiaperta*, *Rhinops vitrea*, *Pterodina patina*, *Mastigocerca bicornis*, and many others.

Testing Objectives.—*The Abbe Test Plate.*—Full directions accompany the test plate, so that the possessor can quickly learn how to use it. It may, however, be stated that it consists of a series of six silvered discs of cover-glass attached to a 3″ by 1″ slip, each cover-glass being of a different and specified gauged thickness, and having lines ruled upon it in a deposit of silver on the under-side. These ruled lines are coarse, and can be separated by low-power objectives.

Information concerning the objectives is gained by the appearance of the edges of each of these lines when illuminated with a condenser of suitable aperture and an eyepiece of high power with a central beam, by oblique illuminations, and by rotating the stage, the correct thickness of cover having first been found by experiment on the test plate.

The condenser used should yield a solid cone of illumination equal to at least two-thirds of that possessed by the objective, and after setting the tube length of the microscope to that for which the objective is best corrected, the procedure should be as follows :—The different discs should be examined until the one is found in which the lines are seen most distinctly. If under no cover good definition can be obtained, nor by a reasonable alteration of tube length, the objective may safely be rejected as bad. It will probably be found, however, that under one of the covers the lines will appear satisfactorily defined, and it will be possible then to ascertain its corrections for spherical aberration, chromatic correction, centreing, etc.

Spherical Aberration.—If the objective will bear an eyepiece of high power satisfactorily on the test plate, it is in itself evidence of good correction in this respect. Further evidence may be obtained by placing a small diaphragm beneath the condenser, so that a cone equal to not more than one-quarter of the numerical aperture of the objective may be yielded, and while looking at the lines, change the position of this diaphragm from central to extremely oblique, the obliquity being in a plane at right angles to the direction of the lines. If the lines remain sharp throughout, the spherical correction is excellent, but if there is a difference of focus, which is still apparent on trying other thicknesses of cover-glass and altering the tube length, and it is impossible to overcome a difference of focus for the intermediate position of the diaphragm, the existence of a spherical zone is proved.

It may be mentioned incidentally that the above method is one of the best for discovering the best tube length and thickness of cover-glass for a given lens.

Chromatic Correction.—This should be tested for in the same manner as the spherical aberration. Under these conditions an apochromatic objective should show practically no colour, or at the very most barely distinguishable traces of tertiary colour.

Well corrected, or semi-apochromatic objectives should show narrow bands of pale green (apple-green) on one side, and a peculiar purple (or claret) on the other side of each line, and should show the same colours for all obliquities—the width of the bands only changing—and give good definition with all obliquities.

Poor objectives will show broad bands of primary colours (yellow and blue) with very oblique light, and the definition will be found to be bad.

Centreing.—Inaccuracy of centreing is shown by unequal definition of the two edges of the central line ; that is, one edge will appear sharp or nearly so, whilst the other will be hazy or seen double, also the coloured edges will be more apparent on one side of the field than on the other.

There is one point that has to be guarded against, and that is the mistake of supposing that want of sharpness on the margin of the field when the centre is in focus is due to spherical aberration or inaccurate centreing. It is really due to want of flatness of field, which is inherent in the construction of all latter day objectives, and particularly so in those of high power.

There is, however, a curvature of field due to *coma*, in which case only the line or lines about the centre of the field can be focussed sharply, those near the margin remaining indistinct under any circumstances.

Definition.—A good standard test for definition is to use such an eyepiece with the objective as will give a magnification in diameters equal to one thousand times the numerical aperture of the objective. Supposing therefore a ½″ objective, having an initial magnifying power of 20 diameters, had a numerical aperture of ·45, an eyepiece magnifying 22½ diameters would be required to give 450 diameters. This in practice becomes a most excellent means of testing the endurance of a lens, and it has the advantage of being based on a rational foundation, the ratio being the same as an eyepiece power of 50 to each inch of aperture on an ordinary telescope. This again is equal to what would be seen of an object when looked at through a pin-hole $\frac{1}{50}$″ in diameter, beyond which the outlines of objects fail in clearness.

Practice with the test plate will soon enable reliable estimates to be formed of the quality of objectives, and these, when confirmed by direct observations on known test objects, will enable the average microscopist to test his objectives for himself.

If any standard tests were ever applied to microscopic objectives, it would not be impossible by means of such an accurate colour-photographic process as the Sanger-Shepherd, to make a record of the colour correction of objectives as seen under specified conditions of illumination on the test plate, and by establishing a standard, to give marks for perfection in this respect.

Mr. John Browning, of 63, Strand, London, has sent for review description and samples of his little micro camera, which are intended to be attached to the body tube of the microscope, the eyepiece being first removed. I have seen this class of camera used at micro *soirées* by ardent photographers who have wished to secure a photograph of a unique or interesting specimen.

The results obtained, of course, are not to be compared with those produced with proper apparatus, but, with practice, fair images can be secured, and it might be that those who made a beginning with one of these little appliances would be induced eventually to extend their work with a suitable camera. The prices of these little cameras are from 5s. upwards.

Growths in Water Mains.—Reference was made in two previous numbers to *Paludicella* in reply to a correspondent, and incidentally it was mentioned that the specimen had been discovered growing in a water main. We have received from a reader the following interesting notes:—"A work which gives much valuable information on this subject is 'The Microscopy of Drinking Water,' by G. C. Whipple. Published by John Wiley & Sons (Chapman & Hall, London), of New York, 1899. The influence of micro-organisms other than bacteria (Schizomycetes) on potable water has received very little systematic attention in this country, but in some of the United States of America it has been carefully studied by properly equipped State Departments, and the book above referred to is the outcome of the writer's experience and study. A very full bibliography is contained in an appendix. It is illustrated with very good plates.

Recently one of the 40″ mains of the Manchester water supply was cleaned out, and 700 tons of animal and fungoid growths with entangled mineral matter removed, the deposit being 3′ thick. A 36′ main in use from 1899 to 1901 yielded 165 tons.

Practical Scheme, Material for Distribution, &c.—A correspondent in Oporto has sent a box of seeds of *Paulownia Imperialis* for distribution amongst readers, remarking that these are beautiful objects mounted either dry or in Canada balsam. If any readers would like to have a small quantity I shall have pleasure in sending it on receipt of a stamped addressed envelope.

The Rev. G. H. Lea, of Jamaica, has kindly sent samples of sand from Dry Harbour Shore and deep-water gatherings, also selected Foraminifera and Mollusca. There is not a large quantity, but so far as it goes it is available for distribution amongst readers who first apply for same enclosing a stamped addressed envelope.

This same gentleman also offers to exchange Foraminifera, Diatoms, sponge washings, or any other things that would be likely to prove of interest from Jamaica to assist in rendering the practical scheme effective in its working. I shall be happy to forward letters.

The Rev. E. J. Holloway desires me to state that the correspondents who have sent tubes to him for Rotifera, will receive them in a few weeks; it being a little early for gathering specimens yet.

In addition to the names given in the March number, Pond Life and Rotifers may be obtained from J. Hood, 50, Dallfield Walk, Dundee, at 1s. per tube, or 26 weekly tubes for 21s.

Consultants.—I am pleased to be able to state that several readers have kindly volunteered to assist in identifying specimens. The subjects so far embraced are Diatomaceæ; Foraminifera and micro-organisms found in marine deposits: Mycetezoa; food drugs and micro-fungi infesting plants. I shall be glad to hear from those who will assist in other departments.

NOTES AND QUERIES.

Richards, C. J. R.—There is no little book on the identification of Foraminifera from Cornwall. Williamson's "Recent Foraminifera of Great Britain," published by the Ray Society in 1858, contains excellent figures and descriptions of the forams then known, but the nomenclature is of course out of date in many instances. Since that date, and especially of late years, there have been an immense number of additions made to the list of British forams. The figures and descriptions are spread over a number of papers in the *Proceedings* of the various societies. The majority of the British species may be found figured and described in the "*Challenger* Monograph of Foraminifera" by H. B. Brady; but this is a large and expensive work, though it may be found in many public libraries. Brady published a Synopsis of the British Forams in the *Journal of the Royal Microscopical Society* for December, 1887. This contains all species recorded up to that time, but there have been many additions since. This paper is invaluable, for although it does not figure any forams it contains full references to the papers in which they are figured. Mr. Earland, who has kindly reported as above, remarks that he will be pleased to assist in naming specimens for you if they are not too numerous. They should be mounted on a card or wood slip, uncovered, and each specimen numbered.

H. E. P.—Mr. Lister, the author of a "Monograph of the Mycetezoa," compiled for the British Museum, wrote the following method of examining and mounting specimens:—"In preparing sporangia for examination, we add a drop of methylated spirit to expel the air from among the spores, and then add water and carefully wash out the spores from amongst the capillitium with the aid of a couple of mounted needles; a little practice will enable you to do this without materially disturbing the arrangement of the capillitium threads. If the specimen is to be kept we add a drop of 1·20 solution of carbolic acid, and mount in glycerine-jelly."

H.—The achromatic condenser in relation to the objective must not be judged by its total aperture, but by the solid cone of illumination that it yields. The first point to determine, therefore, is the aplanatic cone of the condenser that is to be employed. No good objective will bear a cone of illumination equal to its own aperture; three-quarters is generally considered the maximum. If, therefore, you were using an objective having 1·0 N.A., a condenser giving an aplanatic cone of ·75 N.A. would in general be sufficient.

Rev. G. V. G.—It is almost impossible to advise on the choice of a camera lucida because the pattern that suits one may not give good results in the hands of another. All the forms you mention are good ones. The most sensible course would be for you to obtain two or three different kinds for trial and ascertain for yourself which one you could use with the greatest facility. The Beale's neutral tint has always suited me best; there is the defect of the inverted image, and it is probable that you would find Ashe's pattern more convenient and efficient. A note appeared on this in the October number of Knowledge.

Mounting Entomostraca.—*J. H. G.*—A correspondent states that "this may be done in the same way as Mr. Rousselet is now describing for Rotifera. I myself use a 1 per cent. aqueous solution of Beta Eucaine as a narcotic, and kill with a ¼ per cent. solution of osmic acid, and after washing thoroughly mount, as Mr. Rousselet recommends, in a 2½ per cent. solution of formalin. In fact, if 'J. H. G.' follows the instructions given by Mr. Rousselet he will probably find that the only alteration he has to make will be in the strength of the various solutions."

C. H. C.—I am unable to trace a book on Parasitic Leaf Fungi exclusively, but you may be able to select from the following one that will give you the information you require:—"Diseases of Plants" (H. Marshall Ward). The "Fungi-flora" (Cooke) or (Massey), would, of course, have the genera and species of the parasitic leaf fungi among the other fungi, and there is much interesting matter on parasitic fungi in "Fungi: their Nature, Influence, and Uses," by Cooke and Berkeley (International Scientific Series).

H. G. B.—The specimen you have sent can hardly be *Flustra chartacea*, as this species is but 1½" in height, and is distinguished by its small size; it is more likely to be *Flustra securifrons* (Pallas), and followed by Hincks.

G. P.—The simplest and quickest means of measuring objects under examination is with an eyepiece micrometer dropped into the eyepiece to rest on the diaphragm. The value of the lines of this micrometer have first to be taken from a stage micrometer with the objective and eyepiece in use. The blue glass that you use, from the point of comfort is quite sufficient. The object of the green glass is to render the illumination approximately monochromatic. Provided the glass is fairly free from bubbles, &c., there is no reason why it should not be placed immediately beneath the condenser. A stand is necessary when liquid filters or combinations of coloured glasses are used.

J. H. A.—The objectives you mention by Bausch and Lomb are thoroughly good, and you would be quite satisfied with them for general work.

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 V. 1898.—Herr Adolph Hnatek, of Wien, has computed definitive elements for this comet which was discovered by Giacobini at Nice in 1898, June 18. During the months of June, July and August, 94 observations were obtained. The comet appears to have been revolving in an elliptical orbit of great excentricity, the computed period being 42,043 years (*Ast. Nach.*, 3770).

THE APRIL METEORS.—Moonlight will greatly interfere with observations of the shower this year. The maximum will probably occur on the morning of April 22, and the moon will be full on the evening of the same day, so that only the brighter meteors will be visible. In 1901, April 21, there was a moderately plentiful display, and it will be advisable to watch for its return this year, though the brightness of our satellite will rob the event of its conspicuous features.

MAY METEORS.—The moon will have sufficiently waned on the mornings of the first week in May to allow the Aquarids to be satisfactorily seen. This shower presents an orbital resemblance with Halley's comet, and has therefore acquired a special degree of interest. The comet is expected to return to perihelion in 1910, May, and it will be important to watch annually for its associated meteor shower during ensuing years to ascertain whether it intensifies as the earth passes nearer to that section close to the parent comet. The mean position of the radiant is at 336·4° − 2·5°, and this point does not rise in England until shortly before 2 a.m., when morning twilight is strongly in evidence in the north-eastern sky. In southern latitudes the shower can be more successfully observed than in England, as the radiant is visible for a longer period before sunrise. The meteors are swift with streaks, and their paths are abnormally long, a feature which seems characteristic of meteors directed from radiants at low altitudes.

FIREBALL OF 1902, JANUARY 7.—At 8.30 p.m., a very brilliant detonating fireball was seen by many observers in New South Wales. At Sydney the object is described as having increased in size as it travelled along, and as finally exploding in the same manner as a rocket. Some of the fragments travelled eastwards, and "appeared to go down into the sea." At Scone the fireball passed from S.W. to N.E., and two minutes afterwards a tremendous concussion shook the doors and windows. A noise as of distant thunder was also heard. At Gunnedah the blaze of light startled pedestrians, while at Newcastle the earth and sky are stated to have been brilliantly illuminated for several seconds with a beautiful orange-coloured light. Mr. W. E. Besley, the Director of the Meteoric section of the B.A.A., has received about twenty accounts of the meteor, and though most of them are of a very imperfect character he has aproximately determined the real path. The beginning height was 71 miles, over a point 20 miles E. of Muswellbrook, and the object moved to N., disappearing when 28 miles over 20 miles W. of Walcha. Radiant at about 240° — 83° in Octans, but the exact position is doubtful.

LARGE METEORS.—The following have been reported from various places, and it would be useful to have further descriptions:—

1902, January 24, 5h. 25m. Like a large rocket. From N.W. it moved slowly nearly parallel with the horizon towards N.E. Altitude 45°, duration 5 to 8 seconds. H. Sheppard, Bergen, near Bishop's Stortford.

1902, January 24, 12h. 1m. Bright meteor passed from a little E. of α Leonis, towards S. of W., crossing the moon in its flight. Duration 5 seconds, streak lasted 10 minutes. P. Mulligan, Lancaster.

1902, January 30, 6h. 25m. Mag. 1. Path 41¼° + 20° to 45° + 9°. Slow. Reddish-yellow train. Ivo F. H. C. Gregg, Bournemouth.

1902, February 1, 8h. 20m. Brilliant meteor fell to the eastward. It was of a steely-blue colour and descended with an inclination towards N., bursting into fragments in its passage through the atmosphere. G. Taylor, Sbrubland Park.

1902, February 1, 12h. 4m. Equal to Capella. Travelled from near the zenith to N.W. and disappeared in Cassiopeia. Very rapid. Ten minutes later an electric-blue meteor, twice as bright as any star visible, appeared in the zenith and passed due N., disappearing at the Pole star. G. H. Price, London, S.W.

1902, February 12, 11h. 14m. Brighter than Venus. Path 215° + 35° to 195° + 20°. Very swift left a streak for several seconds. Rev. W. F. A. Ellison, Dublin.

1902, February 15, 8h. 25m. Bright meteor shot from direction of Orion and travelled towards west. Duration, 4 seconds. Colour, head blue, tail consisted of three red balls. F. F. Grench, Wimbledon.

1902, March 5, 10h. 35m. Meteor equal to Capella shot from 158° + 70° to 98° + 40°. Duration of flight 2 to 2½ seconds. Rev. W. F. A. Ellison, Dublin.

1902, March 6, 10h. 58½m. Mag. 1 to equal Sirius. Path 108° + 29° to 110° − 2°. The meteor gradually brightened during the second half of its path, and then suddenly vanished. The nucleus was bluish white, with a train of yellow sparks. C. L. Brook, Meltham, Huddersfield.

THE FACE OF THE SKY FOR APRIL.

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

THE SUN.—On the 1st the sun rises at 5.40 A.M., and sets at 6.30 P.M. On the 30th he rises at 4.38 A.M., and sets at 7.18 P.M.

Few sunspots are to be expected.

A partial eclipse of the sun takes place on the 8th, but it is visible only in the high latitudes of the North Pacific Ocean.

THE MOON:—

	Phases.	h. m.
Apr. 1	☾ Last Quarter	6 24 A.M.
„ 8	● New Moon	1 50 P.M.
„ 15	☽ First Quarter	5 26 A.M.
„ 22	○ Full Moon	6 50 P.M.
„ 30	☾ Last Quarter	10 58 P.M.

On the 22nd the moon rises at 7.5 P.M. totally eclipsed; the times of the various phases of the eclipse are as follows, whilst the phase at any particular instant may be deduced from the diagram below:—

	h. m.	
First Contact with Shadow	5 0·2	G.M.T.
Beginning of Totality ...	6 10·2	„
End of Totality	7 35·4	„
Last Contact with Shadow	8 45·4	„
Last Contact with Penumbra	9 55 3	„

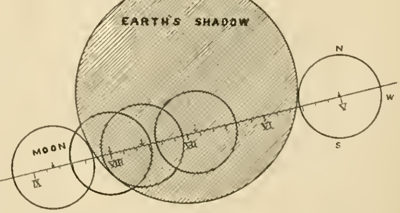


Diagram showing the path of the Moon through the Earth's Shadow and the phase at 8 P.M., April 22nd.

The last contact with the shadow occurs at 60° from the N. point of the moon's limb towards the west.

The magnitude of the eclipse, that is, the distance at mid-totality of the most immersed limb of the moon to the boundary of the shadow nearest the opposite limb divided by the moon's diameter is 1·337.

Of exceptional interest this month are the occultations of the bright stars δ^3 Tauri and Spica, the particulars of these as well as others visible at Greenwich are as follows:—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Apr. 11	δ^3 Tauri	4·2	9 36 P.M.	130	91	10 15 P.M.	230	193	3 7
„ 15	68 Geminorum	5·0	12 36 A.M.	54	15	1 9 A.M.	332	296	6 11
„ 15	27 Cancri	5·6	11 47 P.M.	167	127	12 17 A.M.	229	189	7 9
„ 21	Spica	1·2	11 16 P.M.	148	144	12 52 A.M.	257	242	13 9
„ 25	B. A. C. 5580.	5·7	10 53 P.M.	112	142	12 7 A.M.	268	289	17 8

The Planets.—Mercury is not observable this month, the planet being in superior conjunction with the sun on the 29th.

Venus is in Aquarius, and forms a conspicuous object in the eastern sky shortly before sunrise. She attains her greatest westerly elongation of 46° 12′ on the 29th, on which date she rises at 3.20 A.M., or 1h. 20m. before the sun.

Mars is in close proximity to the sun, and is therefore unobservable.

Jupiter and Saturn are both morning stars, the former in Capricornus, the latter in Sagittarius. About the middle of the month they rise at 3.0 A.M. and 2.15 A.M. respectively. Being somewhat low down in the sky they are not well placed for observation.

Uranus is in Ophiuchus. About the middle of the month he rises just before midnight and passes the meridian at 4 A.M. This, together with its small meridian altitude of only 15°, makes it an inconvenient object for observing.

Neptune is practically in the same position for the first few days of this month as is shown on the chart (in the February number) for the former part of February; now, however, the motion is easterly. About the middle of the month he crosses the meridian at 4.30 P.M., after which he will no longer be observable.

Minima of Algol occur at convenient times on the 1st at 11.57 P.M., 4th at 8.46 P.M., 22nd at 1.39 A.M., 24th at 10.28 P.M., 27th at 7.17 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.

No. 1.

(By A. F. Mackenzie.)

1. R to B4, and mates next move.

No. 2.

(By E. G. B. Barlow.)

Key-move.—1. Kt (Q7) to B5.

If 1. . . . K to B3,	2. B to Kt7ch.
1. . . . K to Kt or Q5,	2. B to B3ch.
1. . . . Any other,	2. B to Kt7ch.

Correct Solutions of both problems received from C. D. Brown, G. W. Middleton, H. S. Brandreth, S. G. Luckcock, Alpha, C. Johnston, G. Woodcock, F. Dennis, H. H. S. (Teddington), W. H. Boyes, A. C. Challenger, W. Nash.

Of No. 1 only, from G. A. Forde (Captain), and an anonymous correspondent at Framlingham College.

Of No. 2 only, from W. de P. Crousaz.

E. G. B. Barlow.—In No. 1, P Queens is answered by B to Bsq, ch. Certainly, there would be no objection to two members of a family competing in the problem tourney.

W. de P. Crousaz.—Please see answer above.

C. C. W. Sumner.—Many thanks; they appear below.

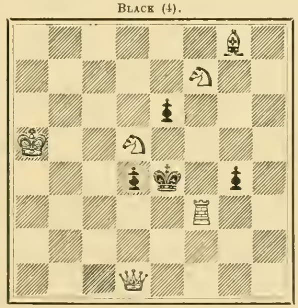
Additional Tournament Problems Received.—"Bargany," "Tubby," "English," "Trifolium," "True Blue," "Seeing the thing through."

PROBLEMS.

By C. C. W. Sumner.

No. 1.

Black (4).

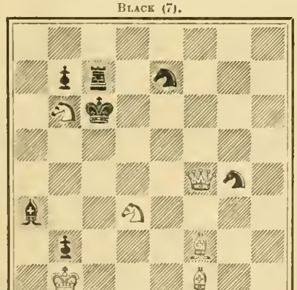


White (6).

White mates in two moves.

No. 2.

Black (7).

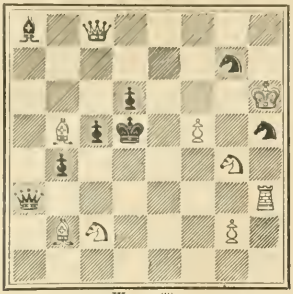


White (6)

White mates in two moves.

No. 3.

Black (8).



White (9).

White mates in two moves.

Intending competitors in the Problem Tourney (for three-move problems) are reminded that entries close on April 10th. I should be glad if solvers of this month's problems would address their solutions to me at 16, Kingston Road, Oxford.

This year's Solution Tourney commences in the next number of Knowledge, and will continue till the end of the year, all subsequent tournaments beginning in January. The winner will hold for twelve months the Knowledge Challenge Trophy, of which an engraving appeared last month. This will become the property of any solver who wins it three years in succession, or four years altogether. In the event of a tie this year the tie will be decided by a further trial of skill under new conditions, but in the event of a tie in any subsequent year, the previous holder will retain possession of the trophy. In that case, however, neither a win nor a loss will be scored to the holder. For example, should the winner of this year's tournament tie for first place with one or more others in 1903, the trophy will become his property if he wins it (without a tie) in 1904 and 1905, or if he wins it three times more altogether, apart from ties.

The second prize will be 15s., and the third prize Knowledge for twelve months. In the event of ties for either or both of these, the ties shall be played off (as above), or the prizes divided at the discretion of the Chess Editor.

The problems published will be either three-move or two-move direct-mates, and not more than three will appear in any number. In the event of any problem being incorrectly printed, it will be cancelled and reprinted. Points will be awarded as follows :—

Two-move Problems.—Any one correct key, 2 points; a second solution, 1 point.

Three-move Problems.—Any one correct key, 4 points; a second solution, 2 points.

One point will be deducted for any one incorrect claim for a second solution. A correct claim of "no solution" will count as a correct key.

In addition to the above, the following special condition will apply during the progress of a problem tournament :—"For each dual continuation on White's second move, 1 point; 1 point being also deducted for each incorrect claim of this nature." When a problem has more than one key, no points will be given or deducted for claiming duals. A "triple," etc, will count only as a dual, and a "repeated dual" will count only as one dual, the Chess Editor being the sole judge as to whether any particular dual shall count as merely a repetition of another dual, or as a separate dual. Any or all of these conditions (except those relating to the Challenge Trophy) may be modified, if found desirable, in future years.

CHESS INTELLIGENCE.

The Monte Carlo tournament came to a conclusion on March 12th with the following result :—

First Prize, G. Maroczy ... $14\frac{3}{4}$	Fifth Prize } C. Schlechter 12
Second Prize, H. N. Pillsbury $14\frac{1}{2}$	Sixth Prize } S. Tarrasch .. 12
Third Prize, D. Janowsky ... 14	Seventh Prize } Herr Wolf .. 12
Fourth Prize, R. Teichmann $13\frac{1}{2}$	

The remaining scores were M. Tchigorin, $11\frac{1}{2}$, F. J. Marshall, 11, I. Gunsberg, $10\frac{3}{4}$, J. N. Napier, $9\frac{1}{2}$, J. Mieses, $9\frac{1}{4}$, J. Mason, 9, M. Albin, $8\frac{1}{2}$, G. Mareo, $7\frac{3}{4}$, Popiel, $7\frac{1}{4}$, Von Scheve, 5, Eisenberg, $4\frac{1}{2}$, Reggio, $2\frac{1}{2}$, Mortimer, 1. It will be noticed that the scores of the first four are extremely close ; in fact there is no noticeable gap till after the sixteenth name on the list. Dr. Tarrasch was naturally out of practice when he started, but picked up rapidly as soon as he recovered his form, and is evidently as dangerous as ever. Marshall fell off towards the finish. Mr. Teichmann for once did himself justice, and proved himself to be the strongest of the British representatives. Mr. Napier made a most successful first appearance for the United States, but Herren Marco and Mieses are below their accustomed places.

The Anglo-American cable match concludes as we are going to press, with the following result :—

British Isles.		America.	
1. T. F. Lawrence	$\frac{1}{2}$	1. H. N. Pillsbury	$\frac{1}{2}$
2. J. Mason...	$\frac{1}{2}$	2. J. H. Barry	$\frac{1}{2}$
3. H. E. Atkins	1	3. F. J. Marshall . .	0
4. F. J. Lee	0	4. A. B. Hodges	1
5. D. Y. Mills	$\frac{1}{2}$	5. E. Hymes	$\frac{1}{2}$
6. G. E. Bellingham ...	$\frac{1}{2}$	6. H. Voight	$\frac{1}{2}$
7. H. W. Trenchard	1	7. E. Delmar	0
8. J. H. Blake	$\frac{1}{2}$	8. C. J. Newman	$\frac{1}{2}$
9. E. P. Michell	0	9. P. Howell	1
10. T. E. Girdlestone ...	0	10. G. Helms	1
	$4\frac{1}{2}$		$5\frac{1}{2}$

The games at boards Nos. 1 and 3 were played, not by eable, but over the board, Messrs. Pillsbury and Marshall being in London on their way home. The British Committee appear to have selected their opponents with great judgment or luck, Messrs. Lawrence and Atkins being notoriously stronger over the board than when playing by cable. The British team were considerably weakened by the absence of Messrs. Blackburne, Jacobs, Ward and Jackson.

All manuscripts should be addressed to the Editors of Knowledge, 326, High Holborn, London; they should be easily legible or typewritten. All diagrams or drawings intended for reproduction, should be made in a good black medium on white card. While happy to consider unsolicited contributions, which should be accompanied by a stamped and addressed envelope, the Editors cannot be responsible for the loss of any MS. submitted, or for delay in its return, although every care will be taken of those sent.

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

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CONTENTS.

STILT-WALKERS.

By E. A. BUTLER, B.A., B.SC.

THE order of insects which is known as Rhynchota (beaked), or Hemiptera and Homoptera, and popularly called "field-bugs," contains many extraordinary forms remarkable for the extreme modification to which one or more of the organs of the body have been subjected. Some particular line of development has been followed to such an extent that it seems impossible to imagine any further modification in the same direction; the climax has been reached, and the possibility of any advance beyond it seems to be barred by the mere physical conditions of existence. The parts that possess the greatest plasticity appear to be the thorax, the legs, and the antennæ. While the most noteworthy developments are seen, as might be expected, in exotic species, our own country furnishes in this order at least one small and interesting collection of insects exemplifying a tendency of the kind referred to. From different families of the British Hemiptera we may select a group of species which have attained in their legs and antennæ the highest degree of length and tenuity that seems compatible with the preservation of these organs at all. Of course a considerable reduction in the thickness of the body has been brought about at the same time, otherwise it would have been too heavy to be supported by the attenuated legs. As these examples belong to several distinct families, it is evident that their slenderness has been independently acquired, and hence we have in these stilt-walkers a good instance of parallel development. Since the insects are absolutely unknown to any but professed entomologists, they have no popular names, and hence, in speaking of them, I am compelled to use their somewhat cumbrous scientific names.

As the first example of this spectral group we will take the insect called *Metatropis rufescens* (Fig. 1). This is by no means a common insect, though when it does occur it can usually be found in some numbers. It is a vegetable feeder, and is specially attached to the plant called "Enchanter's nightshade" (*Circæa lutetiana*), the juices of which it sucks through its slender beak. The plant is an abundant weed in shady places, but the insect is not more than a very occasional accompaniment of it. It is an exceedingly elegant species, with a narrow body of a reddish yellow colour, about five-eighths of an inch long. The thorax rises into a strong hump behind, and is ornamented and, no doubt, strengthened with three prominent keels, like buttresses, one in the middle and one at each side. Behind the thorax the body suddenly narrows and shows a pinched-in waist. The thighs of all the legs are swollen at the tip, or, in other words, end in a club. This is also the case with the first joint of the antennæ, while the terminal joint is wholly swollen and club-like. These clubbed thighs and antennæ are entirely characteristic of the family to which the insect belongs. All these appendages are pale-coloured, and their whole length is thickly spotted with black. The legs end in very small feet, each of which, notwithstanding its minuteness, consists of three joints, and these six minute objects are the only parts that are in contact with the ground.

Such is the insect which may be found in late summer standing on, or walking over, the leaves of the enchanter's

FIG. 1.—*Metatropis rufescens.*

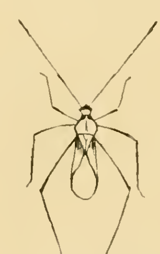


FIG. 2.—*Metacanthus punctipes.*

nightshade, keeping its body well up off the leaf, slung up, as it were, on its six hair-like legs, which act as so many springs. The antennæ, being so much like the legs in both shape and adornment, give the insect the appearance of an eight-legged creature such as a spider, though the length of the body somewhat interferes with the deceptiveness of the appearance. The legs are so extremely thin as to be visible with difficulty at a little distance, when the insect is resting upon the leaves of its food-plant, though they stand out plainly enough when viewed against a background of white card, as would be the case in a collector's cabinet. It is doubtful, therefore, whether the insect is to any extent benefited by its superficial resemblance to a carnivorous and dangerous animal such as a spider. The enchanter's nightshade often grows under beech trees, and the reddish yellow bud-scales of these, as they fall from the tree, may often be seen lying on the leaves of the plant, in which position they look much like the body of *Metatropis*, but this again may be nothing more than an accidental resemblance. There would seem to be two advantages connected with length and slenderness of legs. As already stated, they are practically invisible except at close quarters, and they give, of course, a longer stride, enabling the insect to traverse a fairly long distance in a short time without proceeding at any great speed. But, as *Metatropis* does not appear to wander much, remaining all its life in close association with its food-plant, this last property can hardly be of much service to it.

Another member of the same family is *Metacanthus punctipes* (Fig. 2), a much commoner insect, which can usually be found in sandy places, wherever the rest-harrow, with its pretty pink pea-like flowers, grows. It is a much smaller insect than the preceding, and from the absence of colour in its wings, looks a good deal like a gnat. Anyone who wants to find this curious creature should select a luxuriant patch of rest-harrow on sandy soil in July, August or September. If the outlying branches be lifted up, the probabilities are that *Metacanthus* will be seen in numbers underneath, perhaps both the green larvæ and the greyish looking perfect insect being present together. Under the microscope this is really a very pretty insect; its black head and red neck contrast finely with the yellow thorax with its two black patches in front, and its black-tipped keels. The triangular hinder part of the thorax, or scutellum, carries a curious curved spine, the use of which can only be conjectured. In other respects this insect is like a small edition of the preceding one. Like *Metatropis* it is always found in close association with its food-plant, upon the juices of which it subsists. These two insects very well illustrate the close connection that so often exists between the vegetable and animal worlds; they are natural parasites upon their special food-plants, and their fortunes are entirely dependent upon that of the plants.

Closely allied to these two, and with even narrower body and finer legs, is *Neides tipularius* (Fig. 3). It is a yellowish grey insect, about the size of *Metatropis*, with the same clubbed legs and antennæ, and the same minute feet, but without the black spots on legs and antennæ. Unlike the other two, it does not seem to be attached to any particular food-plant, and indeed is seldom found otherwise than singly and promiscuously. It frequents heathy and sandy places, and may sometimes be discovered lurking under dead leaves, or at the roots of plants in such situations, as well as on the plants themselves. Its sandy colour, and its general slenderness of build, make it difficult to detect when on the ground, provided it has the wisdom to remain still. If it moves, its comparatively large size at once betrays it.

For our next example of stilt-walkers we must go to quite another family, in which we shall find considerable difference in structure as well as in habits, though with the same slenderness of build, or rather with the slenderness accentuated. The best example is *Ploiaria vagabunda* (Fig. 4), which, if we exclude the numerous species of gnats and their allies in the order Diptera, is unquestionably the most delicate insect in our British fauna. All the clubs have practically disappeared from both legs and antennæ, and these have, in their slenderest parts, become considerably finer than human hairs, as may easily be seen by placing a hair beside them. Fine though they are, let it be remembered that they are tubes, carrying within

FIG. 3.—*Neides tipularius.*

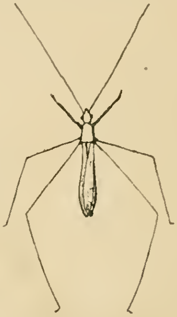


FIG. 4.—*Ploiaria vagabunda.*

them the muscles required for locomotion. Both legs and antennæ are beautifully adorned throughout their length with black rings placed at intervals, and are set throughout with long hairs, which, of course, are much finer than the legs to which they are attached, and are quite invisible to the naked eye. Concurrently with the reduction in the thickness of legs and antennæ, there has been a proportionate lessening of the length of the foot, which is about as short as it could well be. Only two pairs of legs partake of this elongation; the front pair are short, and comparatively stout, and they are noteworthy for the unusual length of their basal joints or coxæ, which, instead of being embedded as usual in the general armature of the body, project considerably, and so give the legs greater freedom of motion. These legs are used for predatory purposes, for the insect, though of so delicate a structure, is strictly carnivorous in habits, feeding upon the juices of other insects, which it catches with these legs. The sucking beak, or rostrum, as usual in this particular family, is short and curved under the head, but not laid close against the breast, as is the case in most other Hemiptera. The upper wings are beautifully mottled with dark grey, making an exquisite pattern like that of grey marble. The hinder part of the thorax carries two long spines, one behind the other, while a third appears at the base of the abdomen. The eyes are very prominent, and the insects have unquestionably good powers of vision, as might be expected from their carnivorous instincts.

These exquisite insects are to be found in all sorts of localities. Often they occur on trees, especially oak and fir, but perhaps ivy and holly are as attractive as anything to them. Of course these trees are frequented not for their own sakes, but on account of the other insects which they harbour. On one occasion I found a large assemblage of them on some oaken palings. Such palings are well known to entomologists as good hunting grounds, and *Ploiaria* had no doubt in this instance discovered the same fact. Although they occur on such trees as above, often in considerable numbers, it would be quite useless to search the branches for them, as their grey colour and extreme slenderness make them quite invisible in such situations. If the branches be shaken or tapped over a sheet or some other clear surface, the insects will easily fall from their perches on to the receptacle awaiting them. But even then it is not easy to see them, and sometimes one finds that one has been looking straight at a specimen without noticing it, till it began to move, and then the eye has become conscious of a sort of faint shifting cloud or shadow, which at last resolves itself into the outlines of an insect. *Ploiaria* is therefore excellently protected. It is almost invisible, at least to human vision, and even when it is seen, it is found to be coloured like a bit of lichen, such as might be found in similar situations; again, like the rest of the order, it has a gland for the secretion of a fluid which probably renders it distasteful, and even if any creature did essay to eat it, it would be hardly worth the trouble, and would prove a very unsatisfactory morsel, as there is so small an amount of matter in the body, and the hair-like legs and antennæ would probably get in the way.

There are two other British species of this extraordinary genus, both of which are much smaller insects, though with equally slender legs and antennæ. The commoner of the two is found not unfrequently in thatch, where no doubt it has a fine time amongst the immense numbers of small insects of every description that delight to congregate in such places, finding thus abundance of prey, with but little trouble to itself. It is about the size and somewhat of the appearance of a gnat, whence the name *culiciformis*, or gnat-shaped, given to it.

To find our next example of these stilt-walkers we must go to the banks of a weedy pond, and here again good eyes will be needed to detect the object of our quest, for we may be looking straight at half a dozen of them and yet not see them until they move. The insect we are in search of is a sooty black one, called *Hydrometra stagnorum* (Fig. 5), a representative of a third family quite distinct from either of the other two, but still exhibiting the same degree of slenderness in both legs and antennæ, though these are not quite so long as in the other instances. It will be found either parading the muddy banks under the shelter of the weeds, or walking on the flat leaves of the water plants as they float on the surface. It is one of a very few insects that have solved the difficult problem of walking upon the water, moving its legs in the same way as when on land, and not with a skating or swimming movement such as is adopted by its relatives.

Fig. 5.—*Hydrometra stagnorum.*

Fig. 6.—*Ranatra linearis.*

It moves equally fearlessly whether along the muddy banks, over the floating leaves of the water weeds, or on the water itself, stepping from the one element to the other with the utmost confidence, and not even wetting its feet in the process. The practicability of this feat no doubt depends upon the extreme slenderness and consequent lightness of the insect, its weight being insufficient to break through the surface tension of even so mobile a liquid as water. Though capable of walking on the water, it never gets far away from the water weeds, and would probably feel itself somewhat lost if it were suddenly transferred to the midst of a broad sheet of water.

If by accident it should become immersed and so get its legs wetted, it finds great difficulty in regaining its position. A specimen which I once watched under these circumstances tried to get out upon the leaves by thrusting its legs above the water close to the edge of the leaf. But each of the fine hair-like limbs, as it emerged from the water, drew out with it a thin film of the liquid which greatly hampered its movements, and evidently needed a hard struggle to get rid of. When at last it had got clear and had apparently escaped from the troubles of capillarity, it was unable for some hours to venture on the water again; each time it attempted to do so, its minute feet gradually slid outwards, and its legs, giving way beneath it, left the poor creature sprawling upon the surface in a perfectly helpless condition. By refraining for some hours from trusting itself to the treacherous element, it ultimately recovered its power, and was able to walk about over the water as freely as before.

One of the strangest features in the organization of this insect is the great elongation of its head, which has evidently been subjected to the same lengthening influences as have operated upon the rest of its anatomy. It projects far in front of the eyes, forming a long snout which broadens at the end. There is almost an equal amount of the head behind the eyes, so that the whole head forms nearly one-third of the length of the insect. Unlike the preceding examples, this insect is scarcely ever met with in a winged condition, both pairs of wings being, as a rule, aborted.

Our last example of these stilt-walkers shall be the insect called *Ranatra linearis* (Fig. 6), one of the so-called water-scorpions, and a member of a family of Hemiptera which is very distinct from all of those already mentioned. One of the most noteworthy distinctions is that the antennæ, which hitherto have been very long, are here quite minute, and are practically invisible unless specially searched for, through being concealed by habitually lying in a depression. This particular water scorpion is not a very common species, and as it lives at the bottom of weedy ponds, only occasionally coming to the surface, it is scarcely ever seen unless caught in a net, or secured by dragging the weeds out of the pond. It is a large insect, far exceeding the dimensions of our other examples, and therefore, of course, its legs, though still very slender for a creature of such size, are not absolutely so thin as in the previous instances. They are, however, sufficiently stilt-like, both in shape and in use, to warrant our including their possessor amongst the subjects of this paper. These thin legs, of course, offer very little resistance to the water as *Ranatra* moves about at the bottom of its pond, or amongst the water-weeds. Anyone who is accustomed to sea-bathing, and knows by experience how laborious a process the human being with his thick legs finds it to make his way on foot through the water, will appreciate the advantage conferred upon *Ranatra* by its spindle-shanks, and hence we see a distinct line along which natural selection may have proceeded in producing so extraordinary an insect. From the figure it will be observed that only two of the three pairs of legs have been modified in this particular way. The front pair have reached a degree of specialization which is even more remarkable. Here the tendency to elongation has been felt in two sections of the legs only, the others being almost dwarfed in proportion to these. The basal joint, or coxa, which, as already pointed out under *Ploiaria*, is usually embedded in the general armature of the body, is here attached by one end only, and is elongated so much as to project far in front of the head. It thus forms a sort of handle, on to which is attached so much of the leg as we generally see projecting from the body. Thus great freedom is secured in the movements of the legs, which are eminently adapted to the predatory operations in which they are concerned. The raptorial character of the leg is further conditioned by the elongation of the thigh and the dwarfing of the tibia and tarsus; the latter two parts are together no more than half the length of the thigh, and they fold back upon it, fitting into a groove along its edge, and so constituting a gripping instrument for the seizure of prey, and presenting that superficial resemblance to the claws of a scorpion, which has suggested the popular name of the insect.

Alike as all these insects are in the length and slenderness of their legs, and in the stilt-like appearance this produces in walking, we are not to regard these resemblances as indicating close relationship. The insects, in fact, do not form a natural group, but, as we have already seen, they belong to at least four distinct families, and the peculiarity of their configuration and development appears perhaps more striking when they are seen, not all grouped together as in this paper, but placed in their proper zoological position amidst the rest of the species of their order, with insects of quite normal form on both sides of them. The order Hemiptera, as a whole, is never indeed noted for thickness of legs, but still these particular species have carried the general tendency to a far greater extreme than the rest of the order, and indeed one can hardly imagine the possibility of any further development in the same direction. And, further, except one section of the order Diptera, there is no other order of British insects that can show similar extremes of development. It is remarkable too, under what diversity of circumstances this similarity of form has been acquired; for, as we have seen, some of our examples are inhabitants of the land, and some of the water; some are vegetarian, others carnivorous; and of those that are vegetarian, some are attached to particular plants, while others are general feeders; some, again, are habitually winged, others habitually apterous, and so on.

THE ANCIENT WILD OX OF EUROPE, AND ITS LIVING REPRESENTATIVES.

By R. Lydekker.

Among many losses attributable, directly or indirectly, to the first French revolution appears to be one which is absolutely irretrievable, and must ever remain a source of the deepest regret to the naturalist. Up to that time there were preserved in Alsace two huge horns commonly reputed to belong to the great extinct wild ox of Europe. The one was preserved in the cathedral at Strassburg, the other in the episcopal palace at the neighbouring town of Zabern, or Saverne. The former was of great length ($6\frac{1}{2}$ feet), and comparatively slender, while the second (which was mounted with silver and used as a drinking-horn) was also very large and apparently stouter. Its length is not given, but its capacity was so great that it would hold four litres of wine.

The French naturalist, Buffon, who saw the Strassburg specimen, believed that it was truly the horn of a wild ox, or aurochs, but this opinion is disputed by Prof. Nehring, of Berlin, who, on account of its great length and slenderness, considers that it belonged to a domesticated Hungarian bullock. This is confirmed by an ancient tradition that the horn in question was that of one of the oxen employed in carting stones for building the cathedral, and Dr. Nehring's view may accordingly be accepted.

On the other hand, the Zabern horn, whose capacity, as already said, was four litres, may, in the opinion of the same authority, be confidently regarded as that of an aurochs. For if it be assumed that its capacity has been somewhat enlarged by shaving away the inner surface, it would seem to accord fairly well in size with large fossil specimens of the bony horn-cores of that animal. For three centuries the Zabern horn was the emblem of an association known as "the brotherhood of the horn." This society was founded in May, 1586, by Bishop John von Manderscheid, who came into possession of the horn as a hunting trophy, or heirloom, from his ancestors. The meeting-place of the society was the castle of Hoh-Barr, near Zabern. The horn was regarded with great veneration by the members of the confraternity, to which distinguished strangers were occasionally admitted as "honorary members." Like the Strassburg ox-horn, the Zabern aurochs-horn mysteriously disappeared during or soon after the French revolution.

With its disappearance vanished apparently the last relic of an aurochs killed within the historic period. It is true that Prof. W. B. Dawkins* has stated that a pair of aurochs-horns were borne in procession on certain occasions in the canton of Uri, Switzerland, so late as about the year 1866, but I am unable to find evidence that the practice is continued, or that the horns are still in existence.

In the middle ages aurochs-horns were commonly preserved—although even then as rarities—in churches and castles, where they were generally used as drinking-vessels; and it is mentioned in the *Commentaries* of Julius Cæsar, that even in his time, such horns, mounted in silver, were employed for the same purpose. In the year 1550, Conrad Gesner mentions that an entire aurochs-skull (apparently with the horns) was preserved in the town-hall at Worms, and another at Mayence. Probably both have long since perished.

Seeing that horns are almost unknown in a fossil state, it might well have been thought that, with the loss of the historic Zabern specimen, the last example of an aurochs-horn had disappeared for ever. By a lucky chance, a nearly perfect horn of the wild ox has, however, been recently discovered in a peat-bog in Pomerania, together with a fragment of the bony horn-core on which it was supported during life. The specimen has been described by Dr. Nehring, and proved to belong unquestionably to the aurochs, as distinct from the bison.

The mention of both aurochs and bison in the preceding sentence, renders it desirable to allude to a matter which has been the cause of considerable confusion and misconception. Until within the last few years, nearly all naturalists regarded these two names as synonymous, and applied them both to the bison; or rather, in many cases dropped the latter name altogether, and miscalled the animal to which it belongs the aurochs. The same practice is largely followed by sportsmen at the present day. In old German the wild ox appears to have been called indifferently either *ur* or *aueroch*; the former name being Latinised by Cæsar into *Urus*. *Auerochs*, according to the usual interpretation, signifies mountain, or wild ox; but opinions differ as to whether *ur* has a similar meaning, or

* *Quart. Journ. Geol. Soc.*, Vol. XXII., p. 393.

whether it signifies the old or primeval ox. Be this as it may, the wild ox, which may even in Cæsar's time have been growing scarce, gradually became rarer and rarer during the middle ages, till it finally disappeared in the first half of the seventeenth century. The name, however, still remained among the peasantry of Eastern Europe, and as there was no species to which it could possibly apply save the bison, which then still survived in Poland and elsewhere, it was transferred to that animal, of which, as already mentioned, it became the common designation. A precisely analogous instance has occurred in Eastern Russia. The bison, in place of being restricted, as now, to Lithuania and the Caucasus, was formerly much more widely distributed. When it disappeared from certain districts, its name still survived, and became transferred by the peasants to the eastern race of the red deer, as the only large wild ungulate with which they were acquainted.

As regards the gradual extermination of the aurochs as a wild animal during the middle ages, much important evidence has been collected of late years by Messrs. Nehring and Schiemenz.

During the Pleistocene epoch, when the mammoth and the woolly rhinoceros inhabited the British Islands and the Continent (which were then one), the aurochs was a common animal, as is attested by the abundance of its remains in formations of that age. Some of the finest and largest skulls of this so-called *Bos primigenius* were obtained by the late Sir Antonio Brady from the brick-earths of Ilford, in Essex. Other skulls have been obtained from the peat of Perthshire, from Burwell Fen, Cambridgeshire, and from a peaty deposit at Newbury, in Berkshire. A skull from Burwell Fen, in the Woodwardian Museum, at Cambridge, has a flint-implement embedded in the forehead, thus showing that the animal was hunted by the Prehistoric inhabitants of our islands at a time when the mammoth and rhinoceros had already disappeared.

As to the date of the extermination of the wild aurochs in Britain there is no decisive evidence, but no skulls or other remains have hitherto been identified from deposits of Roman or later age. It is, of course, possible that it may have survived till the epoch in question, or later, in the more remote parts of the kingdom, and Prof. Dawkins has even suggested that the *tauri sylvestres* mentioned by Fitzstephen, who wrote his "Life of Beckett" in the reign of Henry II., as inhabiting the forests round London, were aboriginally wild animals. On the other hand, they may equally well have been cattle that had run wild, and this is confirmed by Bishop Leslie, of Ross, who stated in 1598 that the *Bos sylvestris* of the Caledonian Forest was white.

On the Continent, we have the evidence of Cæsar as to the co-existence of the aurochs or urus in the Hercynian, or Black, Forest with the bison and the elk. And it is related how the young German warriors of that time prepared themselves for war by hunting and killing the fierce aurochs. A remarkable confirmation of the truth of Cæsar's statement as to the co-existence of the aurochs and bison on the Continent during the period of the Roman occupation is afforded by the discovery in Swabia, during the widening of a railway in 1895, of two statuettes of oxen belonging to the Roman period. They were dug up in loam at a depth of nine feet below the surface, and have been described and figured by Prof. F. Fraas.* The one, as shown by the great elevation and depth of the forequarters, clearly represents the bison. The other, on the contrary, is as evidently intended for the aurochs. The horns have been broken off in both specimens, but what remains of them agrees in each instance with the form they should assume. In stating that both species inhabited the Black Forest contemporaneously, it is not meant that they were actually found in company. On the contrary, it is more probable, as pointed out by Dr. Nehring, that while the one frequented the low-lying and swampy forests, the other resorted to the higher and drier woods.

* "Fundberichte aus Schwaben," Vol. VII., p. 37 (1899).

Of later chronicles than Cæsar's, one describing the wars of Charlemagne in the early part of the ninth century alludes to the king going to hunt bison or aurochs (*bisontium vel urorum*) in the forests of Aix-la-Chapelle. The use of the term *vel* is a little ambiguous, but Prof. Dawkins considers that the passage indicates the occurrence of both species in the forest, while he is also of opinion that the animal slain by Charlemagne was undoubtedly an aurochs. Of special importance is the mention of both bison and aurochs (urus) in a grace used at the Abbey of St. Gall about the year 1000. Another important statement is to the effect that aurochs and elk were met with by the First Crusade when crossing Germany at the close of the eleventh century, special reference being made to the enormous size of the horns of the former animals. Again, in the "Niebelungen-Lied," of the twelfth century, Tregfried is related to have killed a bison and four aurochs near Worms.

At the time Professor Dawkins wrote the account, to which reference has been already made, nothing more was known concerning the history of aurochs from the evidence of contemporary writers till the time of Gesner (1622). A work by the German writer Herberstain, entitled "Moscovia," of which an Italian translation was published at Venice in 1550, affords, however, the most important evidence of any as to the survival of the aurochs in Poland (and probably also in Hungary) during the latter Middle Ages. In this work appear woodcuts—rude, it is true, but still characteristic and unmistakable—of two perfectly distinct types of European wild cattle; one being the aurochs, or ur, and the other the bison. As Herberstain had travelled frequently in Poland, it is probable that he had seen both species alive, and the drawings were most likely executed under his own immediate supervision and direction. It has been suggested that the figure of the aurochs was taken from a domesticated ox, but Messrs. Nehring and Schiemenz have shown that this is quite a mistaken idea. Not the least important feature of the work of Herberstain is the application of the name aurochs to the wild ox, as distinct from the bison. The locality where aurochs survived in Herberstain's time was the Forest of Jaktozowka, situated about 55 kilometres west-south-west of Warsaw, in the provinces of Bolemow and Sochaczew. From other evidence it appears that the last aurochs was killed in this forest in the year 1627. It is important to notice that Herberstain describes the colour of the aurochs as black, and this is confirmed by another old picture of the animal. Gesner's figure of the aurochs, or as he calls it, "thur," given in his "History of Animals," published in 1622, was probably adapted from Herberstain's. It may be added that an ancient gold goblet depicts the hunting and taming of the wild aurochs.*

As a wild animal, then, the aurochs appears to have ceased to exist in the early part of the seventeenth century; but as a species it is still among us, for there can be no doubt the majority of the domesticated breeds of European cattle are its descendants, all diminished in point of size, and some departing more widely from the original type than others. Aurochs' calves were in all probability captured by the prehistoric inhabitants of Britain and the

* *See* Keller, *Globus*, Vol. LXXII., No. 22 (1897).

Continent and tamed; and from these, with perhaps an occasional blending of wild blood, are doubtless descended most of our European cattle.

Much misconception has, however, prevailed as to which breeds are the nearest to the ancestral wild stock. For instance, in 1866, Professor Dawkins wrote as follows:—"The half-wild oxen of Chillingham Park in Northumberland, and other places in northern and central Britain, are probably the last surviving representatives of the gigantic urus of the Pleistocene period, reduced in size and modified in every respect by their small range and their contact with men."

When this was penned, it is only fair to state, the fact that the colour of the aurochs was black does not appear to have been known to the writer; neither was it then generally recognized that the park-cattle (which are always white) are semi-albinoes. Such semi-albinism is always the result of domestication, as is mentioned in Bell's "British Quadrupeds," and could not have arisen in the wild state. Moreover, the park-cattle display evidence of their descent from dark-coloured breeds by the retention of red or black ears and brown or black muzzles. In the Chillingham cattle the ears are generally red, although sometimes (probably as the result of crossing) black, and the muzzle brown; while in the breed at Cadzow Park, Lanarkshire, both ears and muzzle are deep black, and there are usually flecks of black on the head and forequarters. It is further significant that, in the Chillingham herd, at any rate, dark-coloured calves, which are weeded out by the keepers, make their appearance from time to time.

Now it is a remarkable fact that when the black Pembroke breed of domesticated cattle tends to albinism, the ears and muzzle, and more rarely the fetlocks, remain completely black or very dark grey, although the colour elsewhere is whitish, more or less profusely flecked and blotched with pale grey. In the shape and curvature of the horns, which at first incline outwards and forwards, and then bend somewhat upwards and inwards, this breed of cattle, which is known to be of great antiquity, resembles both the gigantic aurochs and the (by comparison) dwarfed park breeds. Moreover, in both the Pembroke and the park breeds the horns are light-coloured with black tips.

Important evidence as to the close affinity between these two breeds is furnished by Low in his "Domesticated Animals of the British Islands." It is there stated that a breed of cattle very similar to that at Chillingham was found in Wales in the tenth century; these cattle being white with red ears. "The individuals of this race yet existing in Wales are found chiefly in the county of Pembroke, where they have been kept by some individuals perfectly pure as a part of their regular farm-stock. Until a period comparatively recent, they were relatively numerous, and persons are yet living who remember when they were driven in droves to the pasturages of the Severn and the neighbouring markets. Their whole essential characters are the same as those (of the cattle) at Chillingham and Chartley Park and elsewhere. Their horns are white, tipped with black, and extended and turned upwards in the manner distinctive of the wild breed. The inside of the ears and the muzzle are black, and their feet are black to the fetlock joint. Their skin is unctuous and of a deep-toned yellow colour. Individuals of the race are sometimes born entirely black, and then they are not to be distinguished from the common cattle of the mountains."

It is thus evident that the white park-cattle are a specialized offshoot from the ancient Pembroke black breed, which, as Low mentions in a later passage, from their soft and well-haired skins, are evidently natives of a humid climate, such as that of the forests in which dwelt the wild aurochs. This disposes, once and for all, of a theory recently broached that the park-cattle are descendants of a white sacrificial breed introduced by the Romans.

A further inference is that the Pembroke cattle are themselves the most immediate descendants of the wild aurochs (which, as we have already seen, was black) now living in the British Islands, or perhaps indeed anywhere else. That the park-cattle have in some cases reverted to a semi-wild state, whereas the Pembrokes are thoroughly domesticated, has nothing to do with the argument, and is merely the result of the force of circumstances.

To some persons the red ears of the Chillingham and some of the old Welsh white cattle may give rise to a doubt as to the relationship with the aurochs and Pembroke breed; but it should be borne in mind that red is the primitive coloration of all wild cattle, and that, for ought we know to the contrary, the calves, or even the cows, of the aurochs may have been of this colour, as are those of the banting or wild ox of Java, of which the old bulls are black. The red ears of the Chillingham breed are therefore, at most, a reversion to the colour of the ancestors of the aurochs.

From the foregoing statements it is evident that the aurochs and the Pembroke and park-cattle belong to one and the same species, and since the latter do not appear specifically separable from the domesticated cattle of Scandinavia, which probably formed the type of the *Bos taurus* of Linnæus, it is clear that the aurochs has no right to a distinct species name. Instead of *Bos primigenius*, it should be called *Bos taurus primigenius*.

In conclusion, it may be mentioned that the article on Four-horned Sheep which appeared some time ago in Knowledge resulted in the presentation to the British Museum of some interesting specimens, and the acquisition of some valuable information with regard to different breeds in which that abnormality occurs. I may now take the opportunity of stating that skulls of the various breeds of domesticated cattle—especially of the Pembroke and park breeds (other than Chillingham)—are much wanted for the National Natural History collection.

ASTRONOMY WITHOUT A TELESCOPE.

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

XIII.—A MODERN TYCHO.

In the Chapter on the "March of the Planets," I remarked, "This field of work has been so completely occupied in modern times by the transit circle and allied instruments that it is now hopeless for the astronomer without a telescope to dream of obtaining results of any value." Yet though this is the case, it has happened even in our own day that circumstances have precluded an astronomer, not merely from using optical means and modern instruments of precision, but even from availing himself of the results which others have secured by their means. This condition prevails in India where religious sentiment places an embargo upon the results of western science. The very essence of Hindu life is the faithful carrying out of a routine of religious observances, inseparably connected with the knowledge of the positions of the planets and stars. For this purpose a full and correct calendar is needed for the right ordering of every Hindu family. To Europeans astronomy is the pursuit of the very few, and the multitude know nothing and care less about the planetary movements. Such ignorance to the Hindu would indicate a blameworthy indifference to the duties of religion and to the requirements of society.

But a serious difficulty has been growing for many years. Two hundred years ago Rajah Jey Singh noted that the calculation of the places of the stars as obtained from the tables in common use, gave widely different results from those obtained by observation; the times and magnitudes of the eclipses of the sun and moon, the times of the risings and settings of the planets, and of the appearance of the new moon, were all faulty; the ancient Siddhantas having been left without revision from the time of Bhaskara, the author of the Siddhanta-Siromani, nearly six hundred years before. It was in consequence of this discrepancy, keenly felt even then, that Rajah Jey Singh obtained the permission of Mahommed Shah to erect observatories in order to obtain new data by which the tables should be corrected. Three of the five observatories erected by Jey Singh are well known, those of Jeypore, Delhi, and Benares. Of these, the one at Delhi, established about the year 1710, appears to have been the first.

The Gentur Muntur, or Royal Observatory of Delhi, though barely two centuries old, is of a thoroughly ancient type in its conception, and was intended for naked eye work alone. Just as at the Royal Observatory at Greenwich the transit circle and altazimuth are considered the two fundamental instruments, so here at Delhi the chief structures were evidently designed for corresponding purposes.

The first object to catch the eye is the great gnomon, the vertical section of which is a right-angled triangle, with an hypotenuse of 118 feet, a base of 104 feet, and a perpendicular height of 57 approximately. The face of the gnomon therefore is parallel to the axis of the earth, its angle corresponding to the latitude of Delhi. Up the middle of the gnomon runs a staircase, and right and left of the gnomon are great sectors on which its shadow falls; these also being provided with steps over which the shadow took four minutes of time, corresponding to one degree of arc, to pass. A smaller structure near has some variations in its design, the gnomon being in the centre and flanked on either side by semi-circles sloping downwards from it towards the horizon. Further to the south of these gnomons, the chief use of which must simply have been to give the solar time, are two large buildings, which are evidently intended to serve as altazimuths. The two buildings are exactly alike in design and size, and they give the appearance from outside of being miniatures of the Colosseum at Rome. Within they are seen to be perfectly circular enclosures. The wall of each is pierced by three tiers of windows, thirty in each tier, the breadth of each window opening being precisely equal to the width of the wall between each pair of windows. The difference between the two buildings is simply a question of position, the two being so arranged that the windows of one command precisely those azimuths which are hidden by the wall of the other. In the centre of each enclosure is a pillar rising to the height of the enclosing wall, whilst from the circular wall thirty stone sectors are directed towards the central pillar, but do not quite reach it. The building is 172½ feet in circumference, or 55 feet in diameter, and the sectors running from the wall towards the pillar are 24½ feet in length. The windows, no doubt, were intended to enable the altitude and azimuth of any celestial object to be read off at sight, and for rough positions no doubt it did fairly well. Still Jey Singh does not seem to have effected any reformation of the Indian Calendar, and his observatories, despite their great size, cannot have been of much value for really scientific work.

The interest of Jey Singh's observatories lies for us in the fact that they recall a time far in the past when astronomers sought for exactness by the erection of huge structures of stone. Of these the Great Pyramid is by far the greatest and most perfect example. The north shaft, pointing to Alpha Draconis, the pole star of the period, the grand gallery which may very well, as Proctor suggests, have been used as a vast transit chamber, give evidence of

The Gentur Muntur, or Royal Observatory of Delhi.

its astronomical purpose, whilst the care with which the exterior of the Pyramid has been oriented, would fix most delicately the dates of recurrence of the spring and autumnal equinoxes. This would be seen from the circumstance that on one day in spring the north face of the Pyramid would be in shadow at sunrise, and the next day the south face, whilst the reverse effect would be noted in the autumn. The exact days of the equinoxes would not indeed be thus pointed out, but the return of the year to the same point would be marked with great prevision.

Britain has its own monument—Stonehenge—which has been claimed as, if not indeed an astronomical observatory, at least an astronomical temple, and many attempts have been made to determine the date at which it was erected. The difficulty, not to say the impossibility, of solving this problem in the present state of the monument may be inferred from the fact that the dates which different careful observers have deduced for its erection extend over a period of more than 2000 years.

The real work of astronomy, even in the pre-telescopic age, was never done in edifices like these. Nor, indeed, does it require much knowledge of human nature, essentially the same 5000 years ago as to-day, to see that the true secret of the Pyramid, the amply sufficient cause for its building, was the vanity of the ruling Pharaoh. We get a graphic hint of this in the narrative in Genesis of the founding of a yet earlier observatory, for so no doubt it was. "They said, go to, let us build us a city and a tower, whose top may reach unto heaven, and let us make us a name." Alike at Delhi, at Ghizeh, and on Salisbury Plain, as by the Euphrates, to "make a name" was, beyond doubt, the exciting motive. Astronomers may have been employed to superintend the work, astronomy, or the cult of the celestial bodies, may have been the excuse, but the real object was advertisement.

But the work which the pretentious buildings of the Rajah of Amber failed to accomplish has been done quite recently by very humble means, and by a recluse in an obscure village in the hills of Orissa.* Chandrasekhara Simha Samanta is a near relative of the Raja of

* *See* Knowledge, Vol. XXII., p. 257. Siddhanta-Darpana.

Khandapara, one of the tributary chiefs of Orissa At the early age of ten, having been taught a little astrology by one of his uncles, he became most anxious to measure on his own account the positions of the stars in their nightly movements, and by the time that he was fifteen years of age and had learned to calculate the ephemerides of the planets and of the risings and settings of stars, he was deeply disappointed to find how great was the discordance between his calculations and what he actually observed. It was no wonder that he found discordances; no two of the current Hindu almanacs agree in their predictions, and one of the most widely circulated of the Bengali almanacs may be as much as 4° out in the longitude of a planet.

In this difficulty Chandrasekhara had to work out his problem unaided. He had to make his instruments for himself, to some extent he had to devise them. The one of which he was fondest is a tangent staff consisting of a thin rod of wood twenty-four digits long, at the end of which is fixed another rod at right angles in the form of T. The cross piece is notched and also pierced with hol s equal to the tangents of the angles formed at the free extremity of the other rod.

For many years he has been carefully revising the Siddhantas in order to bring them into conformity with his observations made at the present period, and he has been able to obtain a most astonishing degree of accuracy in his results. Thus, the sidereal period for Mercury is only 0·0007 days different from that adopted by European astronomers; for Venus it is only 0·0028 days. The mean inclinations of the orbits of the planets to the ecliptic are correct to about a minute of arc. The errors of the ephemerides computed from his new constants are reduced to about one-tenth of those in some of the most widely circulated Hindu almanacs. In his discussion of the moon's motion, he made the discovery—independent and original on his part—of the lunar evection, variation and annual equation, which found no place in the earlier Siddhantas. In much of his work he had the advantage of comparing his observations with those of Bhaskara, made more than seven hundred years earlier; not indeed that the latter had recorded his actual observations, but it was possible to ascertain what they must have been from the planetary elements which he had deduced from them. Nevertheless, to have obtained such important results and so high a degree of accuracy, by naked-eye observations and with entirely home-made instruments, and in the utter absence of modern book learning, is a striking illustration of what resolution can effect.

Chandrasekhara has been compared to Tycho Brahe, and the comparison is in many ways a just one, though the recluse of Orissa lacked many of the advantages possessed by the noble Dane. As to the accuracy of Tycho's work, it will be remembered that Kepler was led to the first of his three great laws by finding that his theory of the circular motion of the planets was irreconcileable with an observation of Mars by Tycho by eight minutes of arc—but one-fourth of the moon's diameter—Kepler concluding that it was impossible that so good an observer could be in error to this extent, abandoned his hypothesis and tried that of motion in an ellipse.

In the recluse of the Orissa village, we seem to see reincarnated, as it were, one of the early fathers of the science, long centuries ere the telescope was dreamed of, as he grappled with the problems which the planetary movements offered to him for solution. More than that, he affords an example of the achievements within the reach of the naked-eye astronomers, and a telling illustration of the precision which patience and practice can give to hand and eye. And these are always needed. For be the telescope ever so good and powerful, still that which is by far the most important is the man at the eye-end.

CLOUDS.

By Commander D. Wilson Barker, R.N.R., F.R.S.E., F.R.MET.SOC., etc.

Those who are professionally engaged in the scientific work of weather bureaux recognise the importance of accurate observations of cloud forms and nature, and much good work has been done in this connection in recent years by scientific observers in England, Australia, and the United States; but, as a popular study, Nephology is almost entirely overlooked, and this notwithstanding the fact that, perhaps, no branch of knowledge offers greater facility and ease of acquisition. Each cloud has its history fraught with meaning; its open secret is writ on its face, and may be read by anyone who will give himself a little trouble, nor need he go deeply into the study in order to make observations interesting to himself, and perhaps of great use in the furthering and perfecting of weather lore. To the ancients, the sky was doubtless an object of constant remark and interest, and possibly their intuitive knowledge of weather forecasting was much more accurate than ours. The dwellers in our modern cities see little of the sky, clouds have no interest for them beyond the personal consideration as to the advisability of taking out an umbrella or not. But farmers, fishermen, sailors and others following open-air avocations are dependent on the weather, and to be wise in its forecast is of importance to them. To these, especially, cloud study should appeal; it cannot fail to be profitable to them in their personal work, and they have all the opportunity, if the will be there, to forward the general knowledge of the subject by careful painstaking observations, which they may transmit to those scientifically engaged in dealing with weather

Fig. 1.—Shower Cumulus.

laws, and thus assist in the elucidation of questions on which we are at present but very imperfectly informed.

In this article the broad distinctions of clouds will be dealt with. There are two well-defined types—Stratus

Plate I. –SQUALL CUMULUS. A Tornado, Sierra Leone, W.C.A 1

Plate II.—PILLAR CUMULUS. 25

Plate III. –CIRRUS. 179

Plate IV. –HIGH STRATUS AND CUMULUS. 6

and Cumulus—so distinct in actual appearance and in physical formation that they may be taken as the basis of classification. Sometimes both types appear to merge into each other, in which case no variety of classification suffices to describe them satisfactorily, as anyone who has studied cloud-forms must allow. "Stratus" is a sheet-like formation of cloud. "Cumulus" is recognizable by its heaped-up appearance and vertical thickness. Numerous

166

Fig. 2.—Squall Cumulus.

varieties of cloud-forms may be observed graduating from one of these types to the other, but when an observer can change, the gradation of Stratus into Cumulus foreboding worse weather, and of Cumulus into Stratus heralding good. Again, as we shall show later on, the vertical thickening of the stratiform clouds is a distinctly bad indication.

Up to quite recently, Luke Howard's division of clouds, formulated in 1802, held first place; even now it is in constant use, for though attempts have been made at a more scientific classification, all of them, with the single exception of that proposed by the late Rev. Clement Ley, can only be termed make-shifts. Mr. Ley's classification unfortunately is long, and not well adapted to the use of any but professional investigators, or enthusiasts with ample time on their hands. There exists a so-called "international" system of cloud nomenclature, but, for all that, each country has its own especial system, with the result that vast collections of cloud statistics are of little value as helps to a classification, and are useful only as records of clouds present at certain times.

Clouds owe their existence to two causes:

1. Through the passing of warm moist air into colder, when, owing to condensation, a certain proportion of the moisture becomes visible in the form of a cloud.

2. Through changes occurring in the atmosphere as it rises into higher regions of atmosphere, where decrease in pressure and expansion and consequent loss of heat take place and cause condensation of moisture.

The first process may be described as the condensation formation of clouds, and the second as the adiabatic formation of clouds. As a matter of fact, no hard and fast line separates these two operations; they act in unison, and the combination of vertical and horizontal currents go to make up the diversity of forms which clouds assume.

In settled states of the atmosphere, Stratus clouds are common, or the sky may be perfectly clear. In unsettled conditions, Cumulus or Heap clouds are formed.

We shall now describe a few familiar forms of cloud,

251 (a)

Fig. 3.—Cumulus.

clearly distinguish Stratus from Cumulus he has already acquired valuable knowledge.

The presence of either type of cloud alone indicates a more or less set condition of the atmosphere, and generally foretells a continuance of the existing weather. The simultaneous presence of both types indicates a coming giving them simple names and endeavouring to compare them with other nomenclatures.

Of Cumulus clouds there are five well-defined varieties as follows:—

(1) Fine weather variety	... ...	Cumulus
Clement Ley	... .	"

International Cloud Atlas ... Cumulus
Meteorological Office Book ... ,,
U. S. Hydrographic Atlas ... ,,

(2) *Rain Cumulus,* of which there are two sub-varieties :—

(*a*) Shower-cumulus (Fig. 1), when rain falls from the cloud without increment of wind. The edges of this cloud are not cirrus-topped.

(*b*) Squall-cumulus, when the rain is accompanied by wind (Fig. 2 and Plate I.), or by wind with hail and snow falling from this cloud.

Clement Ley ... Cumulo-Nimbus
I. C. A. ... ... ,,
M. O. B. ... ... ,,
U. S. H. O. A. ... ,,

In these cases the Cumulus cloud is generally much serrated, having a cirriform edging. In some cases this cirriform edging extends far over the sky and forms halos, particularly at the rear.

Two rarer varieties of Cumulus are :—

Pillar-cumulus (Plate II.) generally noticed over the calm belts of the ocean, and distinguishable by its slender forms, which rise to great altitudes.

251 (*b*)

Fig. 4.—Cumulus.

Roll-cumulus generally accompanies strong winds, particularly polar west winds, which succeed cyclonic disturbances. Here we have the ordinary Cumulus cloud so blown along by the wind as to assume the roll formation from which it is named.

Clement Ley ... ...
I. C. A. ... ...
M. O. B. ... ... Roll-cumulus
U. S. H. O. A. ... Strato-cumulus

133

Fig. 5.—Fog.

A still rarer form of Cumulus appears in scattered patches over the sky, and is indicative of an electrical state of the atmosphere.

Cumulus clouds form at a low altitude, but they frequently tower upwards to great heights.

It should be noticed that in these clouds the fine weather form is of soft smooth outline, and has a quiet appearance. In Fig. 1 (a form which indicates rain) there is a harder and more solid appearance, which is still more accentuated in the Squall-cumulus form of cloud.

Figs. 3 and 4 show respectively a horizontal and vertical view of a Cumulus which, later in the day, developed showers.

Stratus Clouds may be divided into four varieties as follows :—

(1) *Fog* (Fig. 5), so well known as not to need description. It is, in fact, a Stratus cloud resting on the earth's surface.

Clement Ley ... ... Nebula
I. C. A. ... ...
M. O. B. ... ... Fog
U. S. H. O. A. ... ... ,,

(2.) *Stratus* (Fig. 6), a cloud sheet which covers the whole sky at a moderate elevation. Here and there the cloud is thin, and under surfaces appear as parallel lines all round the horizon. This is the characteristic cloud of anti-cyclonic, or dry fine weather conditions. It may continue to cover the sky for several days in succession.

Clement Ley ... ... Stratus Quietus
I. C. A. ... ... Strato-cumulus
M. O. B. ... ... Stratus
U. S. H. O. A. ... ... Stratus

(3) *High Stratus,* including all the varying forms of Cirro-cumulus from the mackerel skies (Fig. 7) to the Cirro-macula (Fig. 8) of Clement Ley. Many beautiful varieties of this cloud of minute cumuliform appearance are caused by the changes taking place in the atmosphere. We notice waves, wavelets, stipplings, and flecks. To it are due the coronæ sometimes seen round the sun, as also iridescent clouds occasionally noticed in the same vicinity. The wave-like appearance of the clouds is due to the

passage of a more rapidly-moving air current over a slower one, or of a wave current crossing a motionless portion of the air. When two air currents pass over one another at an angle, the particles of clouds tend to fall into different shapes, hence our mackerel skies. But this cloud (Fig. 7 and Fig. 9), although beautiful, is essentially one of warning,* more especially when the flecks are of a thin, scaly appearance (resembling the scales of certain fishes so closely that I have called it the scale cloud). Sometimes these detached flecks appear in lines, and very striking is the effect produced.

Fig. 7 and Fig. 9.—C. L. ..	..	Stratus Maculosus.
,, I. C. A.	.	Alto-cumulus.
,, M. O. B.	..	Cirro-cumulus.
,, U. S. H. O. A.		Alto-cumulus.
Fig. 8.—C. L. ...	...	Cirro-macula.
,, I. C. A.	..	Cirro-cumulus.
,, M. O. B.	..	,,
,, U. S. H. O. A.		,,

13

Fig. 6.—Stratus.

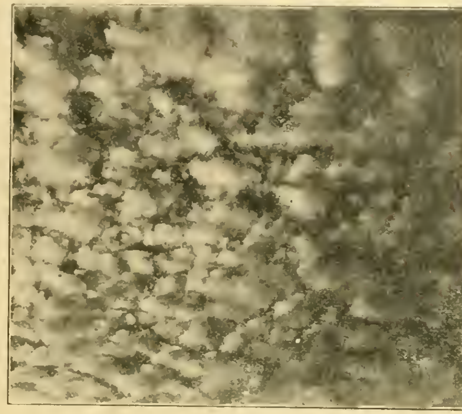
(4) *Cirrus.*—The highest form of cloud and the most important as a factor in the science of weather forecasting. Cirrus, ordinarily, appears as wisps and feather pieces scattered over the sky, and its significance is then of no import (Fig. 10).

Fig. 10—Clement Ley ..	... ...	Cirrus.
,, I. C. A.	... .	,,
,, M. O. B.	... ...	,,
,, U. S. H. O. A.	... ..	,,

When, however, this cloud takes the form of lines parallel to the horizon, or of lines appearing to radiate as wheel-spokes (Plate III.) from any one part of the horizon, it should be carefully noted as indicative of approaching weather. Its movement and propagating transition should be observed. This cloud is composed of ice-dust or crystals.

Plate III.—Clement Ley	...	Cirro-filum.
Fig. 11.—Clement Ley	...	Cirro-velum.
,, I. C. A. ...	...	
,, M. O. B. ...	...	Cirro-stratus.
,, U. S. H. O. A.	...	,,

When a cyclonic disturbance is about to pass over an observer, Cirrus generally appears first in parallel lines, or at a radiant (V) point (Plate III.); the threads gradually increase and interlace until a complete sheet of Cirro-stratus covers the sky, causing a halo (Fig. 11). The cloud further thickens, the halo disappears, all becomes overcast, and rain comes on. The cloud is now known as Nimbus, and after it has endured some time, the wind



205 (a)

Fig. 7.—Mackerel Sky.

shifts, the Nimbus clears off, and it is succeeded by a Polar west wind, and the form of cloud shown in Fig. 2.

In addition to these forms of clouds, we may often

250

Fig. 8.—High Stratus, Mackerel Sky.

notice, particularly during high winds, fragments of clouds hurrying across the sky. These are known as "scud";

* Fig. 9 preceded a heavy gale by about twelve hours.

they are generally pieces carried off by the winds from the main bodies of clouds.

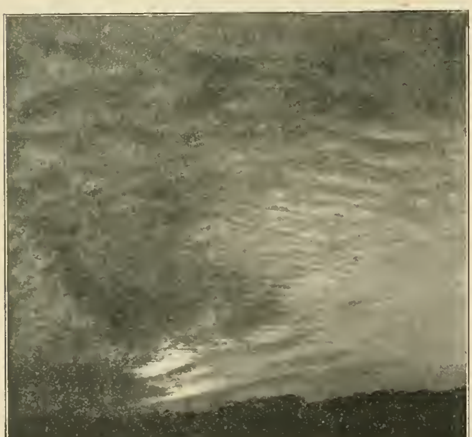
Occasionally two forms of cloud are present at the same time. This is ordinarily taken as a case of Cumulus and Stratus, and has become known as Cumulo-stratus; but, if observed in the zenith, it may readily be noted that the two forms of cloud are distinct, and they had better be dealt with separately. The appearance of Cumulo-stratus is an effect of perspective. (Fig. 12 and Plate IV.)

Clouds float at varying altitudes, according to the latitude and elevation of the ground; the vertical temperature and adiabatic gradients determining the level at which the vapour becomes visible as cloud. It is desirable in all cloud observations, that note should be made of the approximate relative altitudes of clouds and of their velocity of motion. This is particularly desirable when dealing with the stratiform clouds, whether as ordinary Cirro-cumulus or as very high Cirro-macula.

The rate at which they move may be noted from the following table:—

0.—No perceptible motion.
1.—Just moving.
2.—Moving at moderate speed.
3.—Moving quickly.

The beautiful colouring of clouds results from the breaking up of light beams in passing through them or along their edges. This phenomenon is caused by diffraction, and to it is due our lovely sunrises and sunsets. When the sun is high in the heavens, the light is white, but as the orb nears the horizon, and its rays pass through



110

Fig. 9.—High Stratus, Mackerel Sky.

thicker layers of atmosphere, the smaller light waves get gradually cut off, until the sun sinks as a red ball below the horizon. The largest waves of light produce the red rays and the after glow which are so beautiful. Sunrise and sunset effects are matters of much interest, but are of too complicated a nature to be fully gone into here; we must, however, notice them briefly, because of their importance in weather forecasts. Soft sunset colours indicate fine settled weather; fiery brilliant hues denote change to stormy or wet weather.

Other colour effects in clouds are due to phenomena, known as halos and coronæ. Halos appear as rings round the sun and moon; they are caused by the shining of the orb through very high Stratus or Cirrus clouds, and have a diameter of 42° (Fig. 11). Sometimes shades of colour,

130

Fig. 10.—Cirrus.

resembling those of a rainbow, are visible—red appears on the inside and blue on the outside. These rings of colour are due to the reflection and refraction of light passing through the fine ice crystals of which high Stratus or Cirrus clouds are composed. Occasionally a complicated series of beautifully coloured rings is noticeable, producing the effect represented in the accompanying picture (Fig. 13). Generally speaking, these rings are due to the thinness of the high cloud through which the light is passing. Still more curious arrangements of halos sometimes occur.

Coronæ are broader rings seen quite close to the sun or moon, and are due to the shining of light through the edges of loose Cumulus or Stratus clouds. They have red on the outside and blue on the inside of the ring; the colours are, generally, easily distinguishable. The more brilliant hues occasionally seen, as has been said, in the vicinity of the sun and moon, would appear to be incomplete sections of circles intermediate in size between

222 (b)

Fig. 11.—Halo.

coronæ and halos. An interested observer will be well repaid if he chooses to study more closely the many curious optical phenomena connected with clouds, but it would be beyond the scope and object of this notice to go into them more fully here.

Whoever wishes to be weather wise, and who has time to study the weather charts published daily, may easily acquire such knowledge of local characteristics as will enable him to forecast fairly accurately. Cirrus clouds, as a rule—at any rate in England—are reliable guides; they form, as we have said, in parallel threads, from the

62

Fig. 12.—High Stratus and Cumulus.

position and movements of which forecasts may be made. Should the threads appear on, and parallel to, the west horizon, and moving from a northerly point, a depression is approaching from the west, but, although causing some bad weather, it will probably pass to the north of the observer. Should the lines appear parallel to the south-west or south-south-west horizon, and be moving from a north-westerly point, the depression will very likely pass

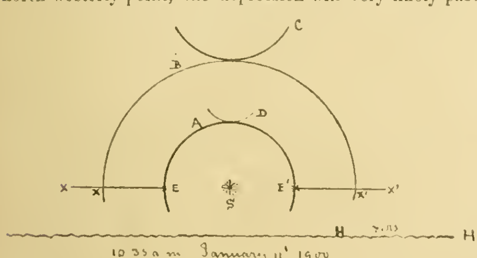


Fig. 13. Ashenden, Sussex.

Explanation.

S.—Sun shining through Cirrus haze.
H.—Horizon.
A.—Inner and bright halo, showing colours, red inside.
B.—Faint large halo, white.
C.—Brilliant portion of halo, showing colours distinctly, red outside.
D.—Small halo, showing faint colours.
E, E¹.—Mock Suns.
E X, E¹ X¹.—Rays from mock suns, white, brighter from East one than from W. one.
It lasted like this for about half-an-hour.

over the observer and occasion very bad weather. These are two of many possible prognostics. Weather forecasting is much helped by a study of the daily weather charts. Again, weather is often very local, and to predict with fair accuracy a knowledge of local conditions is necessary.

It is hoped that enough has been said in this article to attract more than a passing attention to clouds. If an observer be a photographer as well, he will find open to him in Cloudland a fascinating field for study and a limitless variety of subject for his art.

Letters.

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

FAHRENHEIT'S THERMOMETER.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I note on page 29 of your journal for February an article on the history of Fahrenheit's thermometer. Those desiring fuller information can find it, either in the elaborate article by Renou, in the *Annuaire* of the Meteorological Society of France, or in the first chapter of my Treatise on Meteorological Apparatus and Methods, Washington, 1887. There is every evidence that the Fahrenheit scale began with his use of plus 90 as the upper limit of the temperature of the human body, and minus 90 for the lowest temperature of the air in Europe, and also the temperature obtained by the mixture of salt and ice. Subsequently, he also used a second scale in which plus 12 and minus 12 replaced the plus 90 and minus 90. In 1714, he adopted a third scale, viz., plus 24 for the temperature of the body and zero for the lowest temperature at Dantzic in 1709. His fourth scale was plus 96 for the temperature of the human body and zero for the great cold of 1709. This scale gave him 32 as the temperature of melting ice, but that natural point was not directly adopted by him. With this first satisfactory mercurial thermometer (made in 1721, and whose scale was graduated according to this last system but extended much further upward, by extrapolation) he found that the boiling point of water was constant, or nearly so, at 212 deg. The fact that Newton's "arithmetic scale" read 33 or 34 for boiling water, had no influence with Fahrenheit in the formation of his scale. The arbitrary points assumed by Newton were 12 for the temperature of the human body and zero for the temperature of freezing water. I do not find that he measured the temperature of boiling water, and I am very sure that the account of the evolution of the Fahrenheit thermometer, as given by your correspondent, needs to be corrected in several particulars. I am not aware of any evidence that Fahrenheit obtained any of his ideas from Newton's work, and I am sure that those interested in the history of philosophical apparatus will be glad to obtain additional light on the subject.

Cleveland Abbe.

U. S. Department of Agriculture,
Weather Bureau, Washington, D.C.,
March 26th, 1902.

THE VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In the last number of Knowledge Mr. Maunder raises the question as to the visibility of the crescent of Venus with the naked eye, as well as of the satellites of Jupiter under similar circumstances.

My own eyesight is not nearly good enough for either one or the other, but I find that the late Mr. Webb, in his "Celestial Objects," p. 53, states that Theodore Parker saw the crescent with the naked eye in America, and that, *seemingly*, another observer saw it in Chile. He also gives several instances on p. 175 of the visibility of Jupiter's satellites with the naked eye.

I should like to know if Mr. Maunder concurs with Mr. Webb or not.

I can just make out Venus' crescent myself with a binocular of Browning's; diameter of object glass, $1\frac{3}{8}$ inch, focal length, 8 to 9 inches.

Apropos of Mr. C. Jackson's note on p. 81, I recollect that in July, 1873, being then at St. Leonards on a visit, and having, of course, a good horizon, I just managed to see the dark spaces between the rings and body of Saturn, with a small pocket glass by Ross; object glass $1\frac{1}{3}$ to $1\frac{1}{2}$ inches, and power of about 29, a very similar glass to that referred to on p. 2, Vol. I. of Webb.

Pawston, Cornhill-on-Tweed, B. P. Selby.
April 15th, 1902.

[I fear that I cannot add anything to what I have already written as to the crescent of Venus being visible to the naked eye, viz., that I think it "outside the limit of possibility." If it has ever been achieved, then certainly the observer must have been possessed of most exceptional powers of sight. The case of Theodore Parker, quoted by the Rev. T. W. Webb, *may* be a real one, as children sometimes show an acuteness of vision which is not retained in mature life: but I should personally feel no confidence in any statement of the kind that I had not been able to subject to a rigorous testing. I have repeatedly tried to make the observation myself at a time when my eyesight was distinctly above the average in quality. Thus I could at one time count eleven stars in the Pleiades, I have distinctly identified both Uranus and Vesta when in opposition and high in declination, I could clearly separate ϵ_1 and ϵ_2 Lyræ, and I have very often seen Venus at mid-day. But I never could make the slightest approach to defining the crescent of Venus, and the optical assistance necessary to do it has always been considerable. The increase of power which is given by such a binocular as Mr. Selby used is very marked indeed, and I am sceptical as to anyone possessing sight in advance of his fellows to an extent comparable with it. I may have done the American Stoddart an injustice, but I always regarded his claim to have seen the crescent of Venus and to have elongated Saturn with the naked eye as "requiring confirmation."

The case of the satellites of Jupiter is quite different. I see no reason why III. should not be seen at elongation when the planet is high; nor IV. either, though its comparative faintness will render it a severer test of good sight. Under very exceptional circumstances, II. may be elongated almost four minutes of arc and might then be detected under favourable conditions of weather and altitude of the planet. But I should like to receive very full confirmation of any alleged observation of I. There is no reason to call in question observations where two of the satellites have been close together and have been seen as one, if the distance from their primary was considerable at the time.

I shall feel much gratified if my paper induces many observers to seriously take up the question of these observations, which are so nearly on the limit of visibility, and which form such searching tests of goodness of sight.—E. Walter Maunder.]

TO THE EDITORS OF KNOWLEDGE.

Sirs,—During the recent easterly elongation of Venus, I was one evening watching the planet through Mr. Fowler's "Telescopic Astronomy" telescope. A friend, ignorant of astronomy, and *of the fact that astronomical telescopes give inverted images*, called, and was shown Venus through the instrument. To find out if he really was seeing what he was supposed to see, I asked him the shape of the planet—did it seem round? He answered: "No, it is crescent-shaped as it was last night, but *the crescent is turned the other way*." He had, it turned out, been watching Venus the night before with the naked eye.

The incident convinced me that Venus can be seen as a crescent by the naked eye of at least one man, and is, perhaps, worth repeating in view of Mr. Maunder's remarks on page 79 of the April number.

Schoolhouse, James Rodger.
Rattray, Blairgowrie,
3rd April, 1902.

British Ornithological Notes.

Conducted by W. P. Pycraft, a.l.s., f.z.s., m.b.o.u.

Spoonbills in Norfolk.—Mr. J. H. Gurney, in the *Zoologist* for March, gives an exceedingly interesting account of a small flock of Spoonbills which frequented Breydon Water, Great Yarmouth, from early April to the end of July, 1901. Thanks to the efforts of the Breydon Wild Birds Protection Society, none of these appear to have fallen victims to the crowd of gunners who haunted the spot in the hope of securing specimens. It is to be hoped that, in the near future, these birds may be induced once again to nest in their old haunts—the heronry of Reedham, close by. Unless, however, the society receives more liberal support from those interested in the restoration of this and other some-time resident species, the society, we note with regret, will be unable to continue its good work; in which case all hope of restoring the Spoonbill to its ancient stronghold must be abandoned.

We have to record, with regret, that a nearly adult female Spoonbill was purchased at Harrod's Stores, London, during Holy Week of the present year (1902), by one of the taxidermists of the Natural History Museum, Cromwell Road. The bird was in good condition, and perfectly fresh. Careful inquiries show that the bird came from Leadenhall Market, and was said to have come up with a consignment of birds from Great Yarmouth.

Pollination by Birds.—An extremely interesting exhibition of photographs was given at the meeting of the Linnean Society on March 6th, illustrating certain New Zealand plants which depend for fertilization upon certain species of birds. The New Zealand bell-bird *(Anthornis melanura)* is one of these fertilizers; performing this office for the native fuchsias and the native flax. In the course of its visitations the bird's head becomes thickly covered with pollen, so that, at different times of the year, according which of these two plants is in flower, the bell-bird may be obtained either with a bright blue or a red forehead; these colours being due to the pollen. Some years ago this led to a curious mistake, Von Pelzen describing one of the red-headed birds as a new species—*Anthornis ruficeps*. Athough at the time many doubted the validity of this, it was not till 1870 that the supposed new species was abandoned, proof having been given of the artificial nature of the red coloration.

Birds and the Production of Pearls.—At the meeting of the Zoological Society held on March 4th, Dr. Lyster Jameson read a paper on the "Origin of Pearls in the Common Mussel (*Mytilus edulis*)." He showed that the pearls commonly found in these molluscs were due to the presence of a parasitic Distomid larva, which, penetrating the mantle of the mussel, became encysted. On the death of the parasite within the sac, the remains became calcified, and around this nucleus the pearl was formed by the secretion of the epithelium lining the sac. The interest of this paper, to ornithologists, lay in the fact that the adult stage of the parasite was passed in the intestine of the Eider Duck or the Common Scoter, both of which feed largely on mussels.

Longevity of the Eagle Owl.—Mr. J. H. Gurney, in the *Zoologist* for March, records the death of one of his Eagle Owls on February 1st. It was believed to be between thirty and forty years of age. In the same communication he points out the fact that Mr. Meade Waldo has in his possession two birds of this species, one—a male—which is seventy-one, and one—a female—which is fifty-six years of age, and the parent of ninety young ones.

Early Arrival of the Swallow and Sand-Martin.—The *Field*, March 29th, records the arrival of the Swallow at Exeter on March 20th, and of the Sand-Martin simultaneously at Bath and Exeter on the same date (March 20th); and remarks that this is at least a week earlier than usual.

All contributions to the column, either in the way of notes or photographs, should be forwarded to W. P. Pycraft, *at the Natural History Museum, Cromwell Road, London, S.W.*

NOTES.

Astronomical.—Dr. See has recently made an extensive series of measurements of planets and satellites with the aid of the great Washington refractor of 26 inches aperture, giving special attention to the effects of irradiation in increasing their apparent sizes. The following are among the results obtained :—

	As observed at night.	As corrected for irradiation.
Jupiter—		
Equatorial diameter ...	38″·401	... 37″·646 = 141,950 km.
Polar diameter ...	35·921	... 35·222 = 132,810 „
Oblateness		1 : 15·53
Assumed mass		1 : 1047·35 (Newcomb)
Density		1·35 (water = 1)
Saturn—		
External diameter of outer ring	40·274	... 39″·971 = 276,474 km.
Internal diameter of outer ring	34·757	... 34·605 = 239,358 „
Width of Cassini's division	0·418	.. 0·818 = 5,658 „
External diameter of central ring	33·921	... 33·671 = 232,898 „
Internal diameter of central ring	25·932	... 25·932 = 179,368 „
Width of central ring ...	3·995	... 3·745 = 25,904 „
Internal diameter of dusky ring	20·434	... 20·434 = 141,339 „
Width of dusky ring ...	2·749	... 2·749 = 19,014 „
Equatorial diameter of Saturn	17·804	... 17·240 = 119,247 „
Assumed oblateness (H. Struve)	0·1013	
Resulting polar diameter	16·005	... 15·494 = 107,167 „
Assumed mass of Saturn (H. Struve)	1 : 3495·3	
Resulting mean density of planet		0·7105 (water = 1)
Uranus—		
Diameter...		3″·075 = 42,772 km.
Mean density		2·09

The effects of irradiation were eliminated by making observations about the time of sunset, and using a colour screen consisting of a solution of picric acid and chloride of copper in water.—A. F.

Botanical.—*Torreya* for February contains a paper by Mr. B. D. Halsted "On the Behaviour of Mutilated Seedlings." The mutilation consisted of the removal of the plumule. Seedlings of various plants were experimented on, including some of the garden radish. On removing the plumule soon after the plants were above the ground, it was observed first that the cotyledons assumed a much deeper green than usual ; then the petioles developed extraordinarily, becoming three inches long, while the cotyledons attained a breadth of an inch and a half and nearly double the thickness of those of a normal plant. It was also observed that they were raised at an angle of about 45° instead of being approximately horizontal. A microscopic examination showed that the greater thickness of the cotyledons was due to the increased size of the cells, and not to a multiplication of the layers. The roots developed to nearly the ordinary market size. In seedlings of the common sunflower (*Helianthus annuus*), treated in the same manner, a remarkable elongation of the hypocotyl was noticed, this becoming twice as long as in the unmutilated plants.

Among the five plants figured in *Curtis's Botanical Magazine* for March is the first species of the numerous Michaelmas Daisies introduced from North America into European gardens. This is *Aster Tradescanti*. It is a native of the eastern United States, and was first cultivated in this country by John Tradescant, gardener to Charles I., in the royal garden at Lambeth. Tradescant's son travelled in Virginia, and to him is attributed its introduction into Europe. Though this took place about 270 years ago, the present figure is the first to appear, excepting a very rude cut in Morison's "Historia." *A. Tradescanti* has rather small white flower-heads, and is far surpassed in beauty by many more recently introduced species. Other plants figured in the *Magazine* are a handsome new Passion Flower (*Passiflora ambigua*) from Nicaragua, and a very fine Balsam (*Impatiens grandiflora*) from Madagascar. The latter is remarkable for having the largest flowers of all the numerous species of the genus, so far as it is at present known.

At the meeting of the Linnean Society on March 20th, Dr. O. Stapf exhibited some fruits of *Melocanna bambusoides*, a member of the grass family. It will be remembered that the fruits of grasses are nearly always very small, the largest commonly met with being those of the wheat and maize. But in *Melocanna* the pear-shaped fruit attains a length of more than four inches. *Melocanna*, moreover, deviates from the typical grasses in having exalbuminous seeds, a peculiarity present in only three species, so far as has been ascertained, in an order including about 3500. *Melocanna bambusoides* is a native of India, from Assam to Tenasserim.—S. A. S.

Zoological.—According to the preliminary abstract, a paper of much interest and importance, dealing with the evolution of horns and antlers, was read by Dr. Gadow, of Cambridge, before the Zoological Society on March 13th. The author is of opinion that the antlers of the deer, the horn-like protuberances on the skull of the giraffe, and the true horns of the prongbuck and other hollow-horned ruminants (*Bovidæ*) are all different stages of evolution from a single common type : the antlers of the deer being the most primitive, and the horns of the *Bovidæ* the most specialised. From the fact that the bony horn-core of the hollow-horned ruminants develops as a separate ossification, as do the horns of the giraffe, while the pedicles of the antlers of the deer grow direct from the frontal bone, it has been proposed by Dr. Nitshe to place the hollow-horned ruminants (inclusive of the prongbuck) and the giraffes in one group, and the deer in another. This arrangement has the disadvantage of separating the deer from the giraffes, to which they are evidently nearly related; and Dr. Gadow has therefore done good work in bringing them more into line. Whether, however, he is right in regarding the hollow-horned ruminants as derived from the primitive deer may, however, be a matter of opinion. One very important fact—apparently unknown to naturalists, whatever may be the case with breeders—recorded by Dr. Gadow, is that calves and lambs shed their horns at an early age. The *Bovidæ* are thus brought into nearer relationship with the American prongbuck (the only living ruminant which sheds its horn-sheath in the adult condition) than has hitherto been supposed to be the case. It is a pity that the editor of the abstract of the paper did not amend such a very German term as "horn-shoe" into "horn-sheath"; and he might also have pointed out to the author that *Uintatherium*, and not *Dinoceras*, is the proper title for an American group of horned ungulates.

An exceedingly interesting and suggestive paper by Captain Barrett-Hamilton written while on active service in South Africa, appears in the February number of the *Annals and Magazine of Natural History*. It describes certain investigations into the life-history of the salmon, and their bearing on nuptial and sexual ornamentation in the animal kingdom generally. Briefly stated, the author's views appear to be that at the breeding season both sexes of the salmon develop in their tissues a large quantity of proteids and fats. By the female these are used up in the formation of the ova. The male, however, has no need of such a large amount of these substances, and consequently they are worked up in the development of colour, abnormal growth of the lower jaw, etc. On the same principle the author accounts for the development of a gorgeous nuptial (or permanent) plumage in the males of many birds, and the development of brilliant patches of colour in certain male apes like the mandrill. The theory also serves to explain the assumption of male characters by old or barren females of many birds. Whether or no we accept the author's views, wholly or in part, the paper contains much valuable information with regard to the life-history of the salmon.

The fact that the lancelet (*Branchiostoma*) has kidneys apparently indistinguishable in structure from the so-called nephridea of the polychœtous worms has been recently demonstrated by Mr. Goodrich, of Oxford, the results of whose investigations are recorded in the March number of the *Quarterly Journal of Microscopical Science*. If, as is probably the case, the two organs are homologous, the discovery has an important bearing on the phylogeny of the vertebrata.

According to a paper communicated by Miss Donald to the Geological Society, the Palæozoic univalve shells commonly described as *Murchisonia* belong to two distinct types, the one having a slit and the other a sinus in the lip. Whether those with a slit are in any wise related to the shorter-spired and still living genus *Pleurotomaria*, the author was unable to decide.

The April number of the *Proceedings* of the Zoological Society contains an announcement that a pair of giraffes have been promised to the menagerie by Colonel Mahon, Governor of Kordofan. It is hoped that they may arrive in London during the spring. The same number also contains Mr. Thomas's description of the "five-horned" giraffe skins and skulls sent home from Mt. Elgon by Sir Harry Johnston.

Notices of Books.

"British Tyroglyphidæ." By Albert D. Michael, F.L.S., F.Z.S., F.R.M.S., etc. Volume I. (London: Printed for the Ray Society.)—This latest volume of the Ray Society's famous series of monographs is a detailed description of the habits, structure, life-history and zoological position of a group of animals which is very little known. The most familiar representatives of the *Tyroglyphidæ* are the ordinary cheesemites; but the family also includes some eleven other genera which swarm in countless myriads in flour, hay, wooden furniture and dead vegetable matter generally. Only a few of them reach $\frac{1}{50}$th of an inch in length, and many are considerably smaller. The little creatures here described are in many respects of very simple structure, for they possess no definite organs of respiration, circulation, sight, hearing or smell. They have, however, a marvellously delicate sense of touch. They are of comparatively active habits and are in no sense parasites. One of the most interesting parts of the book is that dealing with development. The *Tyroglyphidæ* pass through four well-marked stages: the egg, the six-legged larva, the eight-legged nymph and the adult. In the nymphal stage some genera assume a curious heteromorphous form known as *Hypopus*. The hypopi attach themselves to insects and other animals, and thus secure a very wide distribution. Even to those who are familiar with the refinements of modern biological methods this volume will appear a notable record of an amazing amount of technical skill and patient research. It is well illustrated by nineteen full-page plates.

"The Sacred Beetle: A Popular Treatise on Egyptian Scarabs in Art and History." By John Ward, F.S.A. (John Murray.) 10s. 6d. net. It is well known that the beetles, now called *Scarabaeus* by entomologists, were regarded as sacred animals by the ancient Egyptians. It has been suggested that the habits of these insects in rolling about their balls of dung were considered as typical of the revolution of the heavenly bodies, while the re-appearance of the beetles after a sojourn underground may well have symbolised the resurrection of the dead which formed so important an article of the old Egyptian faith. The scarabs described and figured in a beautiful series of plates by Mr. Ward were representations of the sacred beetle usually cut out of steatite and bearing inscriptions on the lower flat face. Kings and great men had their peculiar scarabs, and these became the records of royal edicts, marriages or hunting expeditions. The oldest scarab figured is one of Neb-ka-ra, the First King of the Third Dynasty (probably B.C. 4212). The use of scarabs died out after the Persian Period (about 500 B.C.). Mr. Ward draws attention to the likeness between the old Egyptian "Kheper" whose hieroglyph was a scarabaeus, and the modern German "Käfer," our own Chafer, which is commonly applied to such insects of the sacred beetle's family as inhabit our islands, hardly, as Mr. Ward seems to think, to the sacred beetle itself. Probably the earliest of these "scarabs" were the oldest representations of insects made by man. At any rate, Mr. Ward's book cannot fail to interest the zoologist, the historian, and the theologian.

"A Text Book of Geology." By Albert Perry Brigham, A.M., F.G.S.A., Professor of Geology in Colgate University. Pp x. and 478. (London: Hirschfeld Bros., Ltd. 1902.) This is an elementary text-book for American schools; and we may conclude, from the absence of the printer's name, that it has been imported ready printed in sheets into this country. Except for the interesting references to American examples and deposits, it would not find sufficient place in England beside the equally compact class-books of Geikie, Lapworth and Jukes-Browne. In the United States, moreover, physical geology and geography are exceptionally well represented in a handy form by Davis and Tarr, while that charming essay of a distinguished author, Heilprin's "Earth and its Story," must already hold a considerable field. Like its American competitors, the present book is well illustrated from actual examples; the scene of mountain-waste at Guttannen (p. 40), the unnamed delta on p. 68, the author's view of the source of the Aar (p. 102), and the glacial hills and lakelets (pp. 207 and 272), may be cited as of especial service. The book is simple throughout, and cannot lay claim to any novelty of method; but at the same time it is both clear and accurate. The progress of geology has been watched by the author, who has even given us on p. 322, quoted from Ruedemann, a "free-swimming colony" of Diplograptus, formed of some twenty axes attached to a central float. There seems to us a lack of the personal element, or of appeal to the great workers of the past century, such as often imparts life to a description, and captures the interest of the beginner; but Professor Brigham's work, utilised by an inspiring teacher, will at least convey no false impressions. In saying this, we pass over the old old statement on p. 97 that *roches moutonnées* were so called from their resemblance to a flock of sheep, for here our author has the best of company. De Saussure was in reality struck by the resemblance of these rounded rocks to the mammillations of a fleece or wig. Probably in his desire to be popular, Professor Brigham speaks of the "Irish Elk" and maintains on p. 388 the familiar distinction between Goniatite, Ceratite, and Ammonite, an arrangement that gives Cerotites undue importance as a group-term equivalent to all the other Triassic Ammonites. Our author, like those before the days of Alpine exploration, ignores the Triassic Ammonites altogether.

A slip that seems worth correcting occurs on p. 197, where gypsum is spoken of as "the only important rock-forming compound of sulphur," "pyrites"—which certainly should be "pyrite" or "iron pyrites"—being given later. The composition of gypsum is not stated. Moreover, were crinoids (p. 325) so named "from their likeness to a lily"? On p. 55, the odd-looking technical word "talus" is usefully connected with "an ankle"; it may be well to note that the Low Latin form *talutum* was used also for a projection, and probably gave rise to the term "talus" in engineering and geology.

Altogether, for American readers, Professor Brigham's work is concise and useful, though it cannot be regarded as a contribution to knowledge.

STUDIES IN THE BRITISH FLORA.

By R. Lloyd Praeger, B.A.

III.—FERNS.

The Ferns whose cool green fronds peep at us from the hedgerows or cluster in shady glens and on damp mountain-sides are an interesting race of plants, and high favourites with all nature-lovers. The differences which separate them from the Flowering Plants and place them, with their allies the Horsetails and Club-mosses, at the head of the vast army of Cryptogams or Flowerless Plants, consist chiefly in the lower type of the asexual generation (what we know as the *plant*) and the prolongation and independence of the sexual generation. In an ordinary Flowering Plant, too, the pause in vegetative growth, when the individual gives rise by means of the dissemination of seed to a number of new individuals, takes place after fertilization has been effected by the union of male and female elements in the flower. When the seed germinates, no cessation of vegetative life takes place until seed has been again formed subsequent to flowering. In the Ferns, on the other hand, the formation of "seed" and dissemination take place *before* the production of the male and female elements. The seed or spore grows into a

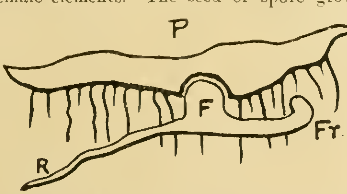


Fig. 1.—Section through a very young Fern. P, the prothallium, with root-hairs on under side. F, foot of young fern-plant, embedded in the hollow of the archegonium. R, first root, and Fr, first frond, of young fern-plant. Much enlarged.

prothallium—usually a minute green heart-shaped prostrate leaf-like growth, on the under side of which the male and female organs (*antheridia* and *archegonia*) are developed. The antheridia liberate a number of *antherozoids*, tiny coiled motile bodies, which twist about and swim in the surrounding moisture, and eventually fertilize the archegonium by fusion with the *ovum*, or egg-cell, which it contains. Fertilization being effected, the growth of the new plant from the ovum commences at once. The prothallium fades away, and the young fern increases in size, and generally lives for many years, producing on the under side of its green fronds abundance of spores, capable of again giving rise to the prothallium form. In other words, there is thus in Ferns a *distinct* alternation of

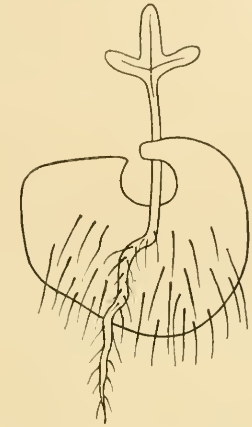


Fig 2.—Young Fern older than in Fig. 1, showing prothallium (under side), and first root and frond of fern-plant. Much enlarged.

generations. The *oophyte* is a minute and normally short-lived plant, while the *sporophyte* usually lives for many years, and sometimes, as in the Tree-ferns, attains very large dimensions. It will be noted that when a "fern" is spoken of, it is the asexual generation, or sporophyte, that is always meant. The non-botanical reader is asked to carefully note the incidents, as briefly sketched, of this life-cycle, in view of certain remarkable departures from it which will be considered towards the end of the present article.

So much for the life-history of Ferns. As regards their history on this earth, Ferns present an immensely long lineage, longer by far than the oldest of the Flowering Plants. They make their first appearance as fossils in Devonian rocks, amid their allies the Horsetails; and in the hot steaming forests of the Carboniferous Period, whose remains form our Coal-measures, they attained a wealth of variety and luxuriance that in the millions of years that succeeded has never again been equalled. Still, they form an important portion of the present vegetation of the globe, numbering, at a low computation, three thousand species, belonging to about sixty genera. Attaining their fullest development in the hot damp Carboniferous forests, they have ever since maintained their preference for heat and moisture. The vast bulk of the three thousand existing species cling to the Tropics, and among the forty-seven species which are found in our Islands, hardly one but seeks a damp and shady situation. To revert to a term used in my last article, Ferns are essentially *hygrophiles*—moisture-lovers—and the student of botanical geography will note how they increase in number as one passes from dry to wet regions—as one leaves the "Germanic" flora of East Anglia, for instance, for the "Atlantic" flora of Wales. Not one of our Ferns is characteristic of sandy or gravelly ground. The Common Polypody selects walls, rocks and tree-trunks for its home, and most of the Spleenworts are wall-plants; in the case of the first, its fleshy, creeping stem stores up water and food for the dry season, while the latter send a network of roots deep into the stonework from the sheltered crevices which they choose for their abode. It may be noted also, that all the wall Ferns vegetate in spring and early summer, and even if completely shrivelled by summer drought, they lie dormant till autumn rains awake them: they possess enough of the impervious characters of xerophytes to prevent entire drying up of their root-stocks. The Bracken grows abundantly on sand-dunes, but its far-creeping rhizome lies deep buried in the sand, beyond the reach of summer suns. In the much-divided nature of their fronds, Ferns also show the characters of a damp-loving and shade-seeking ancestry; where compactness of growth to prevent excessive transpiration was unnecessary, and a spreading out to catch the maximum of light an advantage.

Ferns are classified according to the manner in which the spore-cases are arranged. Of the eight families into which living ferns have been divided, the *Polypodiaceæ*, characterized by the incomplete character of the *annulus*, or ring of thickened cells which encircles the wall of the stalked spore-case, is far the largest, and to it belong all our British ferns except the Filmy Ferns, which are the simplest forms, and the Royal Fern, Adder's-tongue and Moonwort, of which the last two belong to a strangely aberrant group.

Since form of stem determines style of growth, it is worth while considering this character in our British Ferns. We find a considerable variety of stem-forms. Of short, upright stems, such as characterise so many of our higher plants, we have a number of examples. These upright stems often elongate by degrees, as in the Male Fern, Lady Fern, Hart's-tongue. Very old specimens of the Male Fern, and one or two others, may have stems of one to two feet in length, resembling in miniature the Tree-ferns of the Tropics, which, however, belong to a family, *Cyatheaceæ*, unrepresented in our flora. These upright stems are much thickened by the persistence of the bases of the stalks of bygone fronds. In other species the stems are procumbent and slowly creeping; the Maidenhair, *Cystopteris fragilis*, and *Lastrea spinulosa*, furnish good examples. The Common Polypody and Killarney Fern have more rapidly creeping stems, which rest on the surface of the ground. The Polypody is remarkable among our Ferns for having its fronds articulated to the stem, so that they eventually drop off, leaving a scar. But the most far-creeping stems are those which grow below the surface of the ground. The most familiar example is the Bracken, whose vigorous branching stems cover whole mountain-sides with a forest of green fronds. In wind-excavated escarpments in sand-dunes, these black rhizomes, knotted with the stumps of old fronds, may be sometimes seen hanging twenty or thirty feet in length. The Oak and Beech Ferns, the Marsh Fern, Mountain Bladder Fern, and the two Filmy Ferns, have also subterranean creeping stems, and consequently form spreading colonies, instead of the close tufts caused by the occasional branching of upright stems.

To revert to those few British Ferns which are not members of the family *Polypodiaceæ*. The lovely Killarney Fern and the two Filmy Ferns belong to the *Hymenophyllaceæ*, which are the simplest in structure of the Ferns and show some affinities to the mosses. These species are essentially hygrophile. Their delicate pellucid fronds, formed of only a single layer of cells, shrivel at once in a dry atmosphere. They differ also from most of our Ferns in the fact that their fronds are not annual, but will last for a number of seasons. The fronds of *Hymenophyllum unilaterale* will even continue to grow for several years in succession; I have fronds nine inches in length, the result of three successive seasons' growth under close treatment. These delicate species usually seek deep shady dells, where the sun never penetrates; here they clothe damp rocks with their dark verdure, but in some parts of our Islands, as on the west coast of Ireland, the atmosphere is so charged with moisture that on a mountain-side facing north, the Filmy Ferns may form a constituent of the short spongy turf, freely exposed to the weather.

The only British representative of the *Osmundaceæ* is the well-known Royal Fern, *Osmunda regalis*, which needs no description here. Whereas in many of our British Ferns certain fronds produce no spores, but confine themselves to the process of assimilation, while others, whose chlorophyll-bearing area is restricted, bear spores, in the Royal Fern the upper portion of the fronds is set apart for the production of the fructification, the lower parts being expanded, green and leaf-like. But pinnæ may often be found in which every gradation from flat green barren pinnules to narrow fruit-covered ones is present. The remaining ferns, the Adder's-tongue and Moonwort, possess remarkable features. The prothallium, instead of being flat, green and aerial, is a subterranean colourless mass of tissue. The stem, likewise, is subterranean, and very short, sending up each year an aerial branch which divides into two, a spore-bearing portion and a barren leaf-like portion. In the arrangement of the young fronds, too, these plants depart from the almost invariable rule of Ferns, the parts being folded straight instead of coiled up. These Ferns likewise differ from their British allies in their habitat, since their home is in open pastures and heaths, the Adder's-tongue preferring the lowlands, the Moonwort the uplands.

As regards habitat and distribution, our Ferns exhibit a wide diversity. Though none of the species are aquatic, several of the *Lastreæ* frequent wet marshes, notably *L. Thelypteris*. Most of our Ferns are wood and glen plants; some, as already pointed out, seek rocks and walls. While the majority are lowland, many delight in the skirts of the mountains, and a few, notably the two species of *Woodsia* and the Holly Fern, are Arctic-Alpine plants. In opposition to these, the Maiden-hair and Killarney Fern are plants of markedly southern type. One, *Asplenium*

FIG. 3.—Pinna of *Osmunda regalis*, showing transition from barren to fertile portions.

marinum, has its home along the sea-coast. Most, as already stated, are conspicuously hygrophile—lovers of damp air. The Hard Fern and Lady Fern are conspicuously calcifuge, the former especially pining in a limestone soil as rapidly as a Rhododendron; while the Limestone Polypody, the Scale Fern, and *Lastrea rigida* are particularly partial to limestone—strongly calcicole.

Our alpine and arctic ferns are found chiefly in Scotland, the southern and moisture-loving species in West England and Ireland. The calcicole species exhibit peculiarities of range, *Lastrea rigida* and *Polypodium Robertianum*, which are locally abundant on the limestone pavements of northern England, being altogether absent from the similar formation in Ireland, where, in the west, their place is taken by the Maiden-hair. The rock-loving Ferns, especially the calcicole Scale Fern, have had their range greatly extended by human civilization, on account of the building of walls of stone and lime, which form for them an eminently suitable home. But most Ferns are plants of thoroughly wild ground, and decrease with the spread of civilization.

As regards their leafy parts, all our Ferns, with the exception of the Adder's-tongue and Moonwort beforementioned, are arranged on a similar plan. A principal vein or midrib traverses the whole length of the frond, on each side of which the expanded green lamina is arranged symmetrically, the lower portion of the midrib being generally bare and forming a stalk (*stipe*). On the under side of the lamina the spores are produced. It is owing to the cutting and dividing of the lamina that our Ferns possess so much variety. In one species—the Hart's-tongue—the frond is undivided and strap-shaped; in the Common Polypody and Hard-fern it is divided into simple comb-like teeth. In the Male Fern, &c., these *pinnæ* are again cut down to their midribs into *pinnules*. And in the Bracken, Lady Fern, and others the pinnules are in their turn divided into *lobes*. The lower pinnæ in many species are the largest, giving the frond a triangular outline, and in some, as the Oak Fern, the lowest pair are so enlarged that the frond is ternate, consisting of three divisions of nearly equal size.

To return to the question of the reproduction of Ferns. Although their tiny spores are produced literally by the million, Ferns do not submit to artificial cultivation with anything like the readiness displayed by Flowering Plants. The reason is to be sought in their hygrophile proclivities. To raise Ferns from spores, a continuously damp atmosphere is necessary, and if the air is warm also, so much greater the chance of success. But even then the difficulties are not over, for the oophore or prothallium generation is so minute that the seedlings run risk of being smothered by the rich growth of algæ induced by the confined atmosphere. Those Ferns which have creeping stems may enlarge their area indefinitely by means of vegetative growth; and in some abnormal cases, British Ferns reproduce themselves by another vegetative process—namely by bulbils—little buds produced on some portion of the frond, which grow directly into fresh plants. Such bulbils are characteristic of many varieties of *Polystichum angulare*, and occur, though more rarely, on abnormal forms of the Hart's-tongue, Male Fern, Lady Fern, &c.

A much more curious and abnormal mode of reproduction has been brought to light in recent years. Let me recall the normal process in our common Ferns. Sporangia, or cases containing spores, are developed in groups or rows on the under surface of the frond. The spores, being liberated, give rise to small leaf-like prothallia, on the under surface of which male and female organs (antheridia and archegonia) are developed. When fertilization has taken place (which is effected by means of motile antherozoids), vegetative growth at once begins in the egg-cell of the archegonium, and a young fern is the result, the prothallium withering away. In 1868, a very beautiful variety of the Lady Fern was found wild in North Devon by Mr. R. Moule, in which the fronds were large and translucent, the ultimate divisions being very long, slender, and deeply cut. The fern was apparently barren, for though plenty of fructification was produced, no spores could be obtained, and in consequence, in 1883, only two divisions of the plant were in existence. In that year, Mr. G. B. Wollaston discovered in another variety of Lady Fern, that the place of the spore-cases was occupied by numerous bulbils, which were capable of forming new plants by direct vegetative growth. Mr C. T. Druery was led by this observation to examine the sporangia of var. *clarissima*, as the Devon form had been named, and found that they consisted of groups of strange flask-shaped bodies, which were quite unlike spore-cases. These were carefully planted in a seed-pan; they immediately commenced to grow at their tips, which expanded at length into perfect prothallia, which in due course produced male and female organs, and subsequently young fern-plants.* In other words, this remarkable fern was found to produce, not spore-cases and spores, but in place of them prothallia, and to pass from the asexual generation (or fern-plant) to the sexual generation (or prothallium) without the intervention of the spore. In the year following the announcement of this discovery, a still more remarkable phenomenon of a like nature was brought to notice.† Mr. Wollaston observed an abnormal growth proceeding from the tips of the pinnules of the variety *pulcherrimum* of *Polystichum angulare*—also a North Devon find. The tip was found to grow out into a delicate green ribbon, which eventually expanded and thickened into a fully-formed prothallium, on which were developed archegonia and antheridia. "This Polystichum," says Prof. Bower, "is thus an example of the formation of an expansion of *undoubted prothalloid nature* bearing sexual organs, by a process of purely vegetative outgrowth from the Fern-plant—that is, there is a transition in this case from the sporophore generation to the oophore by a vegetative growth, and without any connection with spores, or, indeed, with sporangia or sori. It may be regarded as

FIG. 4.—Prothalloid bodies occupying the place of sporangia in *Athyrium Filix fœmina*, var. *clarissima*. After Druery. Much enlarged.

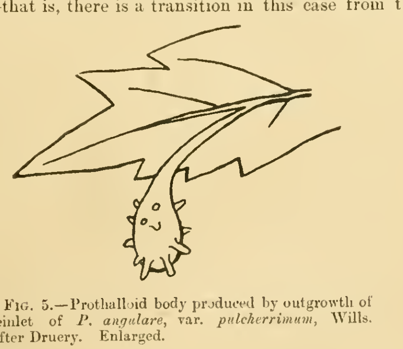


FIG. 5.—Prothalloid body produced by outgrowth of veinlet of *P. angulare*, var. *pulcherrimum*, Wills. After Druery. Enlarged.

* Druery in *Journ. Linn. Soc.*, Botany, Vol. XXI. † Bower, *ibid*

a more complete example of *apospory* than that of *Athyrium Filix-fœmina*, var. *clarissima*"* Two years later, Mr. Druery subjected a different form of the var. *pulcherrimum* above-mentioned—in this second case a Dorsetshire find—to close culture, with the result that not only did the pinnule-tips produce such a number of prothallia that "the pinnæ were absolutely fringed with them," but prothalli also appeared which were produced in quite another manner. Certain veinlets rose out from the surface of the pinnules, and arching over, were prolonged into pendant pear-shaped bodies, which sent out root-hairs, and, under favourable conditions, grew into prothallia.† In 1892 Mr. Druery made another step by discovering prothalloid growth proceeding, not from any one part, but over the whole surface and edges of a seedling crested Male Fern, *Lastrea Pseudo-mas*, var. *cristata*, which, however, lost this prothallium-bearing character as it grew older.‡ In this variety, it should be pointed out, another abnormality of reproduction was already known to occur, namely, the production of the young fern-plant by purely vegetative growth from the prothallium, without the aid of sexual action (*apogamy*). So that in this Fern

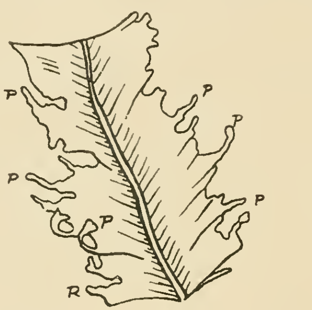


FIG. 6.—Portion of frond of *Scolopendrium vulgare*, var. *crispum Drummondæ*, showing production of prothallia (P, P) along the edge of the frond. Natural size. After Druery.

two remarkable short-cuts in reproduction occur, the sporophore sometimes growing direct from the oophore (by this the sexual organs are eliminated in the life-cycle of the plant), and the oophore sometimes growing direct from the sporophore (by which the spore is eliminated). Mr. Druery continued his investigations, and next announced§ an aposporous Hart's-tongue, a frilled variety, found many years before near Falmouth by Miss Drummond, in which prothalli were produced from the tips of the lobes, into which the margin of the frond is in this form divided. He also discovered another form of *clarissima* Lady Fern, which showed the phenomenon of apospory, not only in the fructification, but also at the apices of the divisions of the frond. Mr. E. J. Lowe,|| in his experiments in prolonging the prothallium generation of Hart's-tongue, by continually subdividing the prothallia (in order to keep the two sexes apart), produced, when sexual action was at length allowed, some extraordinary little Hart's-tongues, of which the fronds were simply masses of prothalloid growth. A characteristic example of apospory occurs in a densely-crested form of the Lady Fern, *Athyrium Filix-fœmina*, var. *unco-glomeratum*, an offspring of var. *acrocladon*, which was

* *Loc. cit.* † Druery, *Journ. Linn. Soc.*, Vol. XXII. ‡ *Journ. Linn. Soc.*, Vol. XXIX. § *Ibid*, Vol. XXX. || *Ibid*, Vol. XXXII.

found wild in Yorkshire in 1860. Dr. Stansfield observed that in the autumn of 1896, when the fronds were dying down, the extreme tips of their bushy crests remained green. He planted these, whereupon they kept growing, slowly unrolling and branching, and the tips eventually expanded into prothallia, which produced young fern-

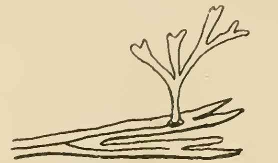


FIG. 7.—*Athyrium Filix-fœmina*, var. *unco-glomeratum*. Young plant arising by budding from prolonged tip of portion of the frond. Enlarged. After Stansfield.

plants by sexual action. Young plants were likewise produced by direct budding, both on the tips of the frond and on the prothallia, so that in this remarkable instance no less than three abnormal processes of reproduction were going on at the same time! *

Apospory in the forms described above is now known to occur in quite a number of Fern varieties of the kinds named above—plumose, crested, and *pulcherrimum* forms—which have been for many years known to be barren varieties, so far as the production of offspring by means of spores was concerned.

So it will be seen that to the normal alternation of generations in Ferns some very remarkable exceptions have been discovered, chiefly among wild British varieties, in which the parts of the frond are very much divided. The phenomenon has been noticed in *Athyrium*, *Polystichum*, *Scolopendrium*, *Lastrea*, and probably *Polypodium vulgare*, and to these may be added the Bracken, *Pteris aquilina*, of which an aposporous form has been found in the United

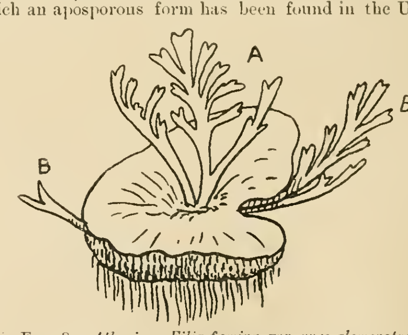


FIG. 8.—*Athyrium Filix-fœmina*, var. *unco-glomeratum*. Prothallium produced by vegetative growth from tip of portion of frond, bearing young plant (A) produced by budding on the surface of the prothallium and also young plants (B, B) produced by normal sexual action. Enlarged. After Stansfield.

States.† The curious outgrowths which result in prothallia may take place in the aborted fructification, on the tips of the pinnules or of crestings, from any portion of the margin or surface of the frond, or from the extremities of projecting veins. The production of these premature oophores appears to be much stimulated by cultivation in a close damp atmosphere—without which, indeed, the delicate prothallia, and the young fern-plants arising from

* Stansfield, in *Journ. Linn. Soc.*, Vol. XXXIV.
† Farlow, in *Annals of Botany*, Vol. II., p. 383, 1888.

them, would have absolutely no chance of life. It is suggested by Dr. Stansfield that apospory may be an atavic trait—"a character that may have been general or even universal in the infancy of the race. This idea is borne out to some extent by the fact that apospory is favoured by a uniformly humid atmosphere, a condition which probably prevailed in early geologic (say Silurian and Devonian) times."* A still more remarkable "short cut" has been detected recently by Mr. W. H. Lang, when experimenting with apogamous ferns. In a Carnarvonshire variety of the Broad Buckler Fern, *Lastrea dilatata*, var. *cristata gracilis*, and a much-branched variety of the Hart's-tongue, *Scolopendrium vulgare*, var. *ramulosissimum*, that observer discovered that sporangia were borne on the prothallia, thus cutting out the whole asexual or fern-plant generation.†

So, as Mr. Druery remarks in a recent‡ summing-up of the question, "it has been now demonstrated that in the sequence of spore, prothallus, antheridia, archegonia, fertilized seed and spore-bearer, every one of the steps, without exception, can be eliminated altogether; thus apospory cuts out the spore and even the spore-heap; bulbils on the fronds or elsewhere, cut out the prothallus; apogamy cuts out the antheridia, antherozoids, archegonia, and fertilized seed; and the spore-bearing prothallus cuts out the sporophore proper."

Note.—The Writer's best thanks are due to his friend, Mr. C. T. Druery, to Dr. F. W. Stansfield, and to the Council of the Linnean Society, for permission to reproduce or adapt Figs. 4 to 8, from the Society's *Journal*.

Conducted by M. I. Cross.

Pond Collecting in May.—All the various pond organisms that die down in winter and in various ways produce protected germs to tide over this, for them, unsuitable season, will now have come to life again and begin to multiply at an increasing rate. Many kinds of Desmids should be found in shallow, mossy pools, or along the edge of rivulets. Among Protophyta and Protozoa the green spheres of *Volvox globator* will be found in many localities more or less abundantly, and the various kinds of Acineta should be looked for in quiet, undisturbed waters, where many kinds of free-swimming Infusoria will also be found.

Of Rotifera there are few species which may not be found in May. At one excursion of the Quekett Club to Totteridge in the middle of May forty different species were obtained. To mention only a few: *Notops brachionus*, one of the most attractive Rotifers, will have made its appearance, then various kinds of *Anuraea*, *Asplanchna*, *Brachionus*, *Coelopus*, *Cathypna*, *Diaschiza*, *Euchlanis*, *Furcularia*, *Mastigocerca*, *Metopidia*, *Pterodina*, *Synchaeta*, *Stephanops*, *Scaridium*: also *Stephanoceros eichhornii*, *Floscules*, *Melicerta*, and *Limnias* in abundance.

On rootlets of trees growing near the edge of ponds and lakes will probably be found various kinds of Polyzoa: *Fredericella Sultana*, *Paludicella* and *Plumatella repens*.

Attachable Mechanical Stages.—Many workers commence with a microscope of plain construction, and as the scope of their work increases find a mechanical stage a real necessity: especially is this the case with students. For ordinary biological and histological purposes a plain stage is not only sufficient but frequently found to be the most suitable, for with constant practice the fingers become educated to moving the object with accuracy and with a rapidity which could not well be attained with a mechanical stage. But when a $\frac{1}{12}$ in. oil immersion is added and systematic examination of a specimen over its entire surface is necessary, and not merely a general observation of its characteristics, the fingers fail to do what is needed. To meet such cases the attachable mechanical stage was devised, and judging by the many patterns that are offered, no small amount of ingenuity has been put into their construction. They unquestionably supply a need, but it cannot be too strongly emphasised how far inferior they are to a good mechanical stage built as a part of the microscope. The fewer detachable parts there are in the instrument the greater is the possibility of affording that rigidity which is such a prime necessity. Take any of the attachable mechanical stages, and none of them are really free from some defect; they have to be self-contained, and as the space in which they work is of necessity constricted, the bearings and fittings have to be of the lightest description, with the result that they rarely work truly, and if they receive a fall or knock are almost irremediably damaged. For any rack and pinion to engage and work responsively and without back-lash the rack must be firmly bedded, and this cannot be accomplished so well in any other form as the fixed stage; no rack with its teeth set on end will ever be nearly so satisfactory. Further, in the attachable stage, when power is put into the milled-head, there is a tendency to shake or lift the attachment; this is an impossibility with the fixed stage.

In view of these facts it is worthy of consideration whether an attachable mechanical stage can be really accepted as a desirable addition to a microscope. The Continental makers, with the exception of Zeiss and Reichert, in their largest photographic stands provide the attachable patterns only, and where necessity has demanded the addition of a mechanical object carrier to a plain stage instrument, its use can be readily understood, but the price charged for them is so high that in nearly all English-made microscopes it is possible to exchange the plain stage for a good fixed mechanical pattern at the same or even less cost, and seeing that the modern fixed mechanical stages are made with a large plain surface on which the specimen can be manipulated with the fingers when low powers are employed, it is to be recommended that a fixed mechanical stage should at all times be obtained where possible, and the attachable form in cases of unavoidable necessity only.

Two-speed Fine Adjustment.—I called attention in the February number to a new two-speed fine adjustment which had been introduced by Messrs. R. & J. Beck, and another interesting device to secure the same result, but by other means, has been devised by Messrs. Watson & Sons. In this case, a single screw only is used, the differences of speed being obtained by two milled heads of different diameters, one being attached to the other. It is an old idea which has been used in micrometer gauges and spectroscopes and is here applied to the microscope.

If a large milled head be turned by the thumb and first finger, it will be found that the rotation is effected very slowly, but if that milled head were one-sixth of the size, it could be turned with six times the rapidity, and herein is the very simple explanation of the little application to Watson's fine adjustment.

The disadvantage of this arrangement is that work will be done by the fine adjustment which should more properly fall to the rackwork coarse adjustment, consequently, in course of time the single fine screw will be likely to show more signs of wear than the coarse screw used by Messrs. Beck for their slower speed, but in any case the action is so simple and effective that there is no reason why every microscope should not be provided with it.

Preparing Mycetozoa.—Mr. M. J. Cole gives the following instructions for mounting these specimens:—Most of these fungi can be mounted dry in glycerine jelly after soaking in equal parts of rectified spirit and glycerine to remove the air, but in those forms which possess lime granules in the capillitium—a character of importance in classification—the calcareous matter disappears when in glycerine in any form Where this is the case, place the specimens in absolute alcohol until all air is removed, then transfer to clove oil, and when clear, mount in Canada balsam.

* *Loc cit.* † *Proc. Roy. Soc.*, LX., p. 250, 1896. *Phil. Trans.*, CXC., B., p. 187, 1898. ‡ *Gardeners' Chronicle*, March 30, 1901.

Some specimens may, however, be rendered too transparent by the balsam, if so, mount them in a shallow cell in some neutral fluid, such as camphor water.

In their ripe condition they may also be mounted dry as opaque objects.

QUEKETT MICROSCOPICAL CLUB.—The list of excursions during the months from April to October, 1902, of the above club, has been sent to me, and those who may wish to become acquainted with practical collecting of micro specimens would do well to put themselves in communication with the Secretary of the Quekett Club at 20, Hanover Square, W., with a view to joining the club itself and taking part in these admirably arranged excursions.

NOTES AND QUERIES.

E. J. H.—A new work entitled "The Foraminifera, an Introduction to the Study of the Protozoa," by F. Chapman, costing 9s., has just been published and it is likely that this may answer your purpose.

T. H. A. The drawing you send is of a hair from the larva of Dermestes Beetle and the specimen is the larva itself. These hairs were at one time considered good test objects, and are in fact not to be despised for the purpose.

Cleric.—The best book for your purpose will be Lewis Wright's "Popular Hand-book to the Microscope," price 2s. 6d.

C. H. C.—In addition to the books named in my previous reply, correspondents recommend "A Text-book of Plant Diseases caused by Cryptogamic Parasites," by George Massee, of Kew, and Plowright's "Uredineæ and Ustilagineæ," Kegan Paul.

O. T. E.—MOUNTING POLLEN GRAINS.—Place these in alcohol and soak for a few days, then transfer to distilled water, then to hæmatoxylin for about fifteen minutes. Wash again in distilled water, dehydrate in alcohol, clear in clove oil and mount in Canada balsam. Carmine may be used instead of hæmatoxylin, if preferred.

Miss Parish.—MOUNTING DESMIDS.—Preserve in acetate of copper solution, and mount in a shallow cell in the same medium.

Story, I. E.—A note on the use of the collar correction of objectives will appear in an early number.

Correspondence is invited on the subject matters dealt with in these columns. Readers may see subjects from different points of view and their criticism will be welcomed.

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 OF 1901.—Prof. Theodor Bredikhine, of St. Petersburg, has written an interesting paper on the character and changes in the tail of this comet. The paper forms a useful contribution to cometary physics, and merits close attention from all those interested in the theory of comets. At the Cape Observatory some excellent photographs were taken of the recent comet, and these have been discussed by Prof. Bredikhine. They give indications that for several hours on April 23rd there occurred a violent eruption of material in an outward direction from the nucleus, and that subsequently to this discharge the nucleus seemed shorn of the usual envelopes. A secondary eruption, of much less prominence than the first, apparently took place on June 2nd, but the comet disappeared soon afterwards, and its further developments could not be traced. Prof. Bredikhine considers that the eruptive disturbance of April 23rd set up a rotatory motion in the nucleus in a similar direction to that of the orbital motion.

SCARCITY OF NEW COMETS.—The exceptional rarity of visible comets alluded to in the November number of KNOWLEDGE continues. During the whole of the past winter cometary observers have had practically nothing to examine in this field, yet in November, 1892, there were seven comets visible! Ordinary comet seekers have alighted upon no new objects since Giacobini at Nice announced his last discovery on 1900, December 20, which is sixteen months ago. This absence of comets is remarkable when we consider the large number of these bodies which were detected during the last quarter of the nineteenth century. It seems highly probable that many of these interesting and mysterious objects escape observation owing to the inadequate means taken to effect their discovery. It is to be hoped that in following years more observers will engage in this research, for, if it requires close application and no small amount of patience, it is almost certain to be successful in the end.

LARGE METEOR. On the beautifully clear evening of March 23rd, at 7h. 25m., a fine meteor, nearly as brilliant as Venus, was seen by the writer at Bristol. It passed very slowly through Ursa Major, its flight being from 188° + 76° to 190° + 35°, and duration 4½ seconds. The nucleus was pear-shaped and yellowish; it left no enduring streak or train, but threw off a few red sparks as it rolled along. The probable radiant of the meteor was at 11° + 39° near the great nebula in Andromeda and its probable height 71 to 45 miles from above Worcester to Thame. It may have belonged to the same stream which furnished a pretty bright meteor on 1887, March 27, at 8h. 47m., and which was seen by Mr. T. W. Backhouse at Sunderland, and by the writer at Bristol. The radiant was at 11° + 35°, and the heights 59 to 55 miles, velocity 10 miles per second. Another fully recorded observation of the meteor of March 23rd last would be valuable, and enable its real path to be accurately determined. It was an unusually interesting object, and typical of that numerous class of fireballs which appear in the early evening, and are often directed in long slow flights from radiants at low altitudes in the western region of sky. Later on the same evening (March 23rd, 8h. 50m.) another very conspicuous meteor was noticed at Bristol by some casual observers, passing from left to right along the N.E. sky, but it has been impossible to ascertain any further particulars concerning it.

BRIGHT METEORS ON MARCH 29.—At 8h. 16m. p.m., Mr. J. Halton, of Manchester, observed a meteor rather brighter than Sirius, shooting towards the head of Serpens from between α and ε Boötis. Motion rapid, duration about 1½ seconds. At 9h. 45m. another meteor appeared a few degrees under α Coronae and ζ Herculis, and travelled along from right to left in a direction almost parallel with those stars.

BRIGHT METEOR ON APRIL 10.—At 13h. 28m., the writer, at Bristol, observed a meteor brighter than 1st mag. crossing the star α Ophiuchi. It traversed a path of 10 degrees from 262½° + 16° to 261½° + 6°, and appeared to be rather foreshortened and not very far from its radiant, probably near 265° + 37°, 268° + 48°, or 276° + 69°. Colour bluish-white, motion rather swift.

THE FACE OF THE SKY FOR MAY.

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

THE SUN.—On the 1st the sun rises at 4.35 A.M., and sets at 7.19 P.M. On the 31st he rises at 3.52 A.M., and sets at 8.3 P.M.

Sunspots are infrequent, but there are indications that the abnormally long period of minimum is drawing to a close and occasional spots may be looked for. There is a partial eclipse of the sun on the 7th, but wholly invisible in this country though visible in New Zealand and the South Pacific Ocean.

THE MOON:—

	Phases.	h. m.
May 7	● New Moon	10 45 P.M.
„ 14	☽ First Quarter	1 40 P.M.
„ 22	○ Full Moon	10 46 A.M.
„ 30	☾ Last Quarter	12 0 NOON.

There are only two occultations conveniently observable this month; there is, however, a *near approach* of the moon to α Librae; the following are the particulars:—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
May 12	12 Cancri	6·5	10 37 P.M.	181	141	10 51 P.M.	211	172	5 0
„ 15	36 Sextantis	6·5	9 19 P.M.	108	84	10 30 P.M.	301	268	7 23
„ 21	α Librae	3·0	1 18 A.M.	12	350	—	—	—	14 3

THE PLANETS.—Mercury is an evening star in Taurus, and after the first few days is well placed for observation. On the 28th, he attains his greatest easterly elongation of 23° 3′, and is situated about 2° north of ι Geminorum; on this date the planet remains above the horizon until shortly after 10 P.M., or more than two hours after the sun has set.

Venus is a morning star in Pisces, she forms a conspicuous object in the morning sky shortly before sunrise, rising about 1h. 20m. in advance of the sun. During the month the apparent diameter diminishes from 23″·0 to 17″·4, and about the middle of the month the illuminated portion of her disc is 0·589 and answers to the appearance of the moon 8 days old.

Mars is practically unobservable, as he rises only about half-an-hour previous to the sun.

Jupiter is still in Capricornus, rising on the 1st at 2.5 A.M., and on the 31st at 12.11 A.M. His path is a short easterly one near to ι Capricorni. The apparent diameter is increasing, being 35″·8 on the 1st, and 39″·4 on the 31st. He is in quadrature with the sun on the 7th.

Saturn is also a morning star, rising on the 1st at 1.15 A.M., and on the 31st at 11.12 P.M. The planet describes a short looped path in Sagittarius, reaching the stationary point on the 8th. The apparent diameter of the planet is about 16″·0, whilst that of the outer major and minor axes of the ring are 40″·7 and 14″·8 respectively; the northern surface of the ring is presented to us.

Uranus remains in the most southerly part of Ophiuchus near 44 or *b* Ophiuchi. At the beginning of the month he crosses the meridian at 2.43 A.M., whilst on the 31st he crosses at 12.45 A.M.

Neptune is practically out of range, being rather low down in the north-west and lost in the strong twilight.

THE STARS.—About 10 P.M. at the middle of the month Ursa Major will be nearly overhead; Arcturus a little east of south, and Spica Virginis on the meridian; Leo in the south-west, and Gemini in the north-west; Cygnus in the north-east; Vega high up in the east; Scorpio rising in the south-east.

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.

(By C. C. W. Sumner.)

No. 1.

[We beg to supplement the composer's apologies for this unfortunate problem. The author's intention was 1. R to QB3, but there is a mate in one move, besides two other solutions by 1. Q to Kt3, and 1. Kt to B3ch.]

No. 2.

1. Q to Q4, and mates next move.

No. 3.

1. R to R4, and mates next move.

CORRECT SOLUTIONS of the three problems received from W. de P. Crousaz, W. Nash, Alpha, J. M. K., H. S. Brandreth, G. W. Middleton, Black Knight, G. A. Forde (Captain), C. D. Brown, F. Dennis, C. Johnston, G. Woodcock, A. C. Challenger.

Of No. 1 and No. 3, from H. Boyes.

Of No 1 and No. 2, from H. H. S. (Teddington), Major Nangle.

Major Nangle.—In No. 3, if 1. R to QKt3, K moves and escapes.

H. H. S.—If 1. R × Kt, K moves.

W. Harris.—A dual mate in a two-move problem will not count. But no two-move problems will be published this year.

Composer of "White Bishop."—Problem withdrawn as requested.

Vox Australis.—You may have seen by now that the Knight's attempt to "perform the feat off his own bat" (January four-mover) is defeated by Black's device for obtaining a stale-mate position.

C. C. W. Sumner.—Many thanks for the revised position; I regret that there is no more space for two-move problems this year. But if you send it elsewhere, I should recommend you to examine the effect of 1. R × B.

Composer of "All's well," etc.—The problem must take its chance as to the date of its appearance. You will see that it is not drawn for publication this month.

H. B. Dudley.—I much regret that, as you sent your name and address, instead of the necessary motto and *sealed* name and address, your problem cannot appear in the tourney.

Composer of "Donabo atque vincam."—Please see the reply above. Apart from this I think you will find that the problem has at least two other solutions (1. R to B6ch, and 1. Kt to K5ch). With so much hostile force in the neighbourhood of the Black King I do not think that you will succeed in making the problem sound.

Moha Shaida Ali Khan.—I regret that I am compelled to exclude the four problems on the ground that the composer's names appear on them. In addition to this they arrived two days too late. The one marked No. 3 is, I think, by far the best, and I should recommend the composer to enter it in some other competition. The others, though all have sacrificial keys, are not of the kind preferred by English Tournament judges.

Composer of "Post tenebras lux."—Your problem has three solutions in two moves, and must be excluded, therefore, as "obviously unsound."

PROBLEM TOURNEY.

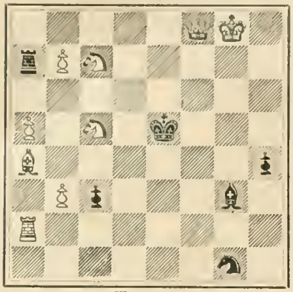
ADDITIONAL TOURNEY PROBLEMS RECEIVED.—"Ariadne," "Per Aspera ad Ardua," "Algol," "Vega," "Brutum Fulmen," "With how much labour," etc. "Poor Pink," "Leonard," "Weighty," "Circumstances alter Cases," "Inter pocula," "Possibilities," "Knowledge rather than choice gold," "By indirection find direction out," "Variety charms," "Three steps and a shuffle off," "Fort nachanand," "Without Hope," "Ben trovato," "Aller güten Dinge sind drei," "All's well that ends well." Seven others received cannot be entered owing to non-compliance with the rules, or, in one case, obvious unsoundness. It is possible that I may find others ineligible on this last account; but if all survive a very cursory examination the total number of accepted entries (including eight previously acknowledged) will be twenty-nine, a very satisfactory number. In order to get the result published within a year it will be necessary to print three problems each month. The order of publication will be decided by lot, and this month the lot has fallen on the following:—

PROBLEMS.

No. 1.

"Per Aspera ad Ardua."

BLACK (6).



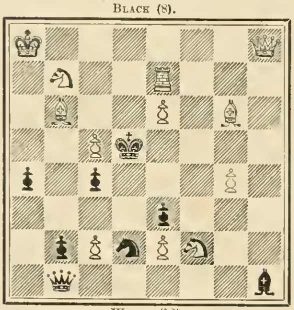
WHITE (9).

White mates in three moves.

No. 2.

"Fort nachanand."

BLACK (8).



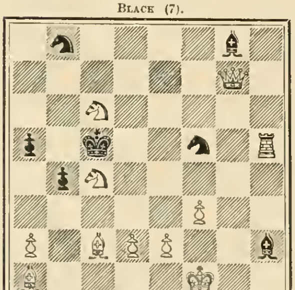
WHITE (12)

White mates in three moves.

No. 3.

"Algol."

BLACK (7).



WHITE (11).

White mates in three moves.

Solvers are reminded that those who solve correctly every problem in the tourney will be entitled to act as preliminary judges. It is as well to explain that by "solving a problem correctly" I mean giving the correct key (if there is one and only one), *and no other.* But no solver will be disqualified from judging on the ground of failure in a problem which proves either incapable of solution, or capable of more than one solution. The proviso of solving every problem correctly was clearly only intended to ensure that the preliminary judges had appreciated the merits of every problem which could have *any chance of success;* and this end is met by limiting the proviso to the case of sound problems. I need hardly add that failure in duals will not be a ground for disqualification.

SOLUTION TOURNEY.

This begins with the problems printed above, and will continue to the end of the year. During the publication of *Tourney* Problems duals will count, as explained last month. Solutions must bear postmark of the *issuing* office *not later than* the 10th day of the month of publication. I regret that the time for solution cannot be extended; but the task of examining claims for incorrect solutions, second solutions, duals, etc., involves considerable labour, and this page goes to the printer before the middle of the month.

CHESS INTELLIGENCE.

The Inter-University Match took place at the British Chess Club on March 21st, and resulted in a draw. The score is as under:—

OXFORD UNIVERSITY C C.		CAMBRIDGE UNIVERSITY C.C.	
Mr. W. M. Grundy, All Souls	0	Mr. H. A. Webb, Trinity ...	1
Mr. H. F. Davidson, Exeter...	1	Mr. F. W. Clarke, Pembroke	0
Mr. H. D. Roome, Merton ...	1	Mr. B. Goulding-Brown, Trinity	0
Mr. J. R. W. Robinson, New College	0	Mr. H. Bateman, Trinity ...	1
Mr. A. C. Ernsthausen, Balliol	0	Mr. A. C. Prichard, Queen's...	1
Mr. H. Taylor, Balliol	1	Mr. H. A. Stead, Emmanuel ..	0
Mr. G. Walker, University ..	½	Mr. M. Rittenberg, Caius ...	½
	3½		3½

On the following day Lancashire defeated Yorkshire (30 aside) at Manchester by 17½ games to 12½.

The brilliancy prize in the recent Monte Carlo Tournament has been awarded to Mr. James Mason for his game with Mr. Napier.

Mr. W. Ward is the winner of the City of London Club Championship this season. Mr. D. Y. Mills, for the second time, I believe, in the course of his career, has failed to win the Championship of Scotland.

The *Hampstead and Highgate Express* announces its fifth tourney for two-move problems. Entries to be made before May 1st. The first prize is one guinea, and half-a-dozen other prizes, of chess books, are also offered.

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CONTENTS.

THE VIBRATION PRODUCED BY THE WORKING OF THE TRAFFIC ON THE CENTRAL LONDON RAILWAY.

By Charles Davison, sc.d., f.g.s.

In January, 1901, a Committee, consisting of Lord Rayleigh, Sir J. Wolfe Barry, and Professor J. A. Ewing, was appointed by the Board of Trade "to consider and report to what extent the working of the traffic on the Central London Railway produces vibrations in the adjacent buildings, and what alterations in the condition of such working or in structure can be devised to remedy the same." The report of the Committee was presented last January, and was followed in April by the publication of a series of appendices by Mr. A. Mallock, in which the details of the experiments are described. The present paper contains a summary of the methods employed by the investigators and of the results at which they arrived.

The Committee first heard the evidence of several residents near the line, who all agreed as to the objectionable character of the vibrations, and then ascertained by personal observation that their complaints were well-founded. As the disturbances arising from successive trains were found to vary much in intensity, concerted observations were also made by about a dozen persons stationed in different houses near the railway-line. Lastly, Mr. A. Mallock was deputed to make a careful study of the nature and extent of the vibration; and it is to his scientific insight and perseverance that the Committee attributes in great part the successful solution of the problem set before them.

Experiments were first made with a seismometer that recorded mechanically and magnified the movements of the ground or floor ten times. But, this being found insufficient, another instrument was used that recorded photographically and had a magnifying power of 75.

The principle of this instrument is the same as that employed in vertical-component seismographs. A weight is suspended by a spring from a support connected with the framework of the apparatus, and is so arranged that the period of the suspended weight is long compared with that of the vibration to be measured. When the ground or floor moves, the weight either remains practically at rest or its movement is shown on the record as long oscillations on which the rapid vibrations of the ground and point of support are superposed (Figs. 3 and 4).

The essential part of the apparatus is shown in Fig. 1.

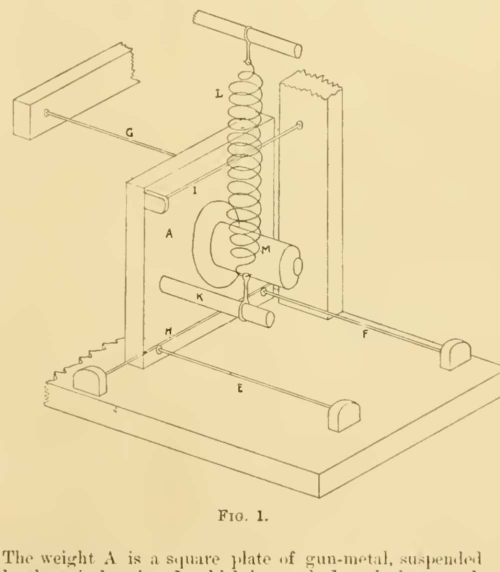


Fig. 1.

The weight A is a square plate of gun-metal, suspended by the spiral spring, L, which is attached, at the lower end, to the horizontal arm, K, projecting from the plate, and, at the upper end, to a support connected with the frame. Five steel rods, E, F, G, H, I, maintain the heavy plate in a vertical position. The ends of these rods are pointed, and one end of each rests in a conical steel cup on the plate and the other end in a similar cup on the frame. The rods E, F and G compel the plate to move only in its own plane, the rods H and I prevent it rotating or moving horizontally in that plane, while the attachment of the spiral spring, L, to a point near the outer end of the eccentric arm, K, places all the steel rods in a state of longitudinal compression; so that, if the weight is displaced in a vertical direction, its return is resisted by the thrust of the rods. The resultant force tending to restore the weight to its former position depends, therefore, on the difference between the force exerted by the spring and the vertical components of the thrusts of the rods. By adjusting the point of contact of the spring and the arm K, this resultant force, and consequently the period of oscillation of the plate, can be varied at pleasure. It was found by trial that a period of about four-fifths of a second was long enough compared with the period of the vibrations to be measured, while a much longer period rendered the instrument too sensitive to changes of temperature.

The movements of the plate A with respect to the frame were registered photographically, in order to avoid the friction introduced by a mechanical recorder. For this purpose, a microscopic objective, M, one-sixth of an inch in focal length, was fixed to the plate with its axis horizontal. In its focus was placed a horizontal quartz fibre mounted on a stage, S, attached to the frame (*see* Fig. 2, the stage being omitted from Fig. 1 to simplify the diagram). Close to, but just short of, the conjugate focus of the objective, a vertical cylindrical lens, N, is fixed, and, the field of view being illuminated by a lamp at L, there appears in the focus of this lens a moderately bright

Fig. 2.

vertical line on which the image of the quartz fibre is cast as two black dots on either side of a very bright dot. The photographic plate, P, on which this image is received, was made to travel at the rate of about three-quarters of an inch a second; and the records on the negative, when developed, showed a dark line bordered by two narrow bands of nearly clear glass. The sensitiveness of the instrument may be judged from the fact that records are clearly given of every footfall of a horse when distant more than a hundred yards.

The vibrations in the ground are due to the passage of a heavy load over an uneven surface. If the wheels were absolutely circular and the rails perfectly straight and yielding uniformly throughout, there would be nothing to cause vibration.

In the Central London Railway none of these conditions is fulfilled. The rails are bridge rails in continuous contact with the sleepers, which are laid longitudinally and are bedded on concrete. This, however, varies in depth, being least over the flanges of the sections of the tube. In the intervals between the flanges, the yielding under a heavy load would therefore be greater than in the parts immediately above them, and this may in time cause a permanent unevenness of the rails.

But a far more serious cause of vibration lies in the fact that the rails, when first laid, are not straight. As they leave the rolls the rails are curved, and they are then bent under a press at intervals of two or three feet until they appear straight to the eye of the trained workman superintending the operation. This process naturally results in a slight waviness of surface, the average depth of the hollows being, as Mr. Mallock ascertained, about $\frac{1}{20}$th of an inch, and the average distance from crest to crest between $1\frac{1}{2}$ and $2\frac{1}{2}$ feet, though deeper hollows and longer waves are of frequent occurrence.

Again, the wheels, though nearly circular at first, wear irregularly owing to the action of the brakes, the slipping which takes place in travelling round curves, and possibly to variability in their material. A pair of wheels that had been in use for more than a year on the Central London Railway were found to be worn so that they were no longer concentric with the axles, and were also furrowed by minor waves.

There must thus be a continual variation of pressure between the wheels and the rails, and it is to this that the objectionable vibration is due. It is important to notice that the variation of pressure is not proportional to the total load on the wheels, but to that part of it which is not supported by springs. The part of the load which is spring-borne moves practically in a horizontal line without following the inequalities of the rails, so that there is no change of any consequence in the pressure corresponding to it.

The diagrams obtained by Mr. Mallock show that the vibrations of the ground caused by the passing trains are of many different periods. When, however, they are large and well-marked, the principal vibrations are found to be nearly constant in period, whatever be the speed of the train and however greatly the inequalities in the rails may vary in length. The reason of this is that the irregular impulses given by the uneven rail-surfaces set up an oscillation of the rails and the road-bed, which may be regarded as an elastic support loaded with that part of the mass which is not carried by springs.

Mr. Mallock remarks that a somewhat similar case is that of a ship rolling at sea. Whatever be the period of the waves, the period of rolling is very nearly that of the ship when it rolls in still water. It is only when there is a long succession of equal waves that the period of the rolling approaches that of the waves.

A few of the diagrams obtained by Mr. Mallock are given in Figs 3 and 4. Those in Fig. 3 represent the vibration caused by an ordinary locomotive and train in No. 19, Hyde Park Terrace, the upper curve, *a*, showing the vibration in the basement, and the lower, *b*, that on the first floor. The vibrations caused by the train have a period of about $\frac{1}{15}$ of a second, and are, in both cases, superposed on longer waves due to the swinging of the heavy plate of the vibration apparatus. These diagrams show very clearly how much greater is the vibration on the first floor than in the basement of the building.

The series of curves in Fig. 4 were obtained on the ground floor of No. 13, Hyde Park Terrace. The first

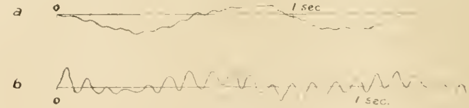


FIG. 3.

three diagrams, *a*, *b*, *c*, represent the vibration caused respectively by an ordinary locomotive and train, a geared locomotive and train, and a multiple unit train. The last curve, *d*, shows the vibration of the same floor caused by a single light stamp of the foot. The effects of the different kinds of trains will be referred to afterwards. For the present it is worth noticing how much the vibration caused by stamping exceeds that due to any one of the trains.

The smallness of the objectionable motion is, indeed, one of the most remarkable results of the Committee's work. In the solid stone or floors in the basements and in the walls themselves, it was rarely found to exceed one or two ten-thousandths of an inch, and such vibrations, even if they recurred at the rate of fifteen per second, would in all probability escape notice. On the higher floors, however, the vibrations have an amplitude which may amount to, though it seldom exceeds, a thousandth of an inch, but it is these vibrations, when their frequency is over ten per second, that have given rise to such widespread annoyance.

From the last curve, *d*, in Fig. 4, it is clear why the vibration should be so much more marked on a floor than in the basement. We see that, after a single stamp, the floor makes quite a large number of oscillations before it comes to rest again; also, if we compare the curves *a* and *d* in the same figure, that the period of the floor's oscillations is very nearly the same as that of the principal vibrations caused by passing trains. Thus, vibrations, which in the basement are almost imperceptible, produce increased vibrations in the floors, just as one particular string of a piano resounds if the corresponding note be struck outside. How greatly the original vibrations may be magnified depends on the closeness between their period and that of the floor's oscillations, and on the slowness with which the latter die away. If the two periods happen to be nearly equal we may, therefore, expect a well-made floor to have larger vibrations set up by resonance than one in which the boards are unsound and the joists badly laid.

In the opening inquiry, nearly all the witnesses examined by the Committee stated that at times unusually severe vibrations were felt. As these might be caused by particular trains, simultaneous observations were made during one day in three houses from which complaints had been received. The observers were placed in different rooms and noted the times at which the vibrations were felt, and also estimated roughly their intensity, whether severe, moderate or slight. Others in the two adjoining

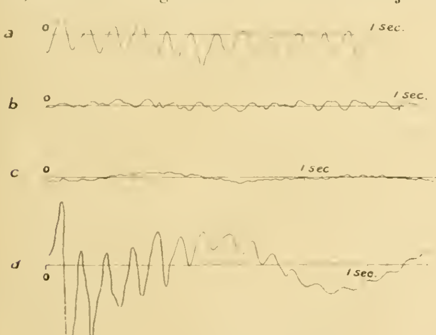


FIG. 4.

stations noted the times of arrival and departure of the trains, which were about 300 in number. The analysis of the observations showed: "(*a*) That it was a matter of chance whether a given locomotive caused a slight or a severe vibration; (*b*) That trains causing severe vibrations in one house were as likely as not to cause only slight vibrations in the others; (*c*) That different rooms in the same house were not similarly affected by the same train." Owing to the waviness of the rails and wheels, and to the random manner in which the irregularities of the wheels meet those of the rails, it is evident that there may be times when several pairs of wheels may be in a position to cause strong vibrations simultaneously.

When the work of the Committee began, the locomotives in use weighed forty-four tons, and the unspring-borne load on each of the four axles was eight tons. Two new types were constructed shortly afterwards, and were tested by the same methods. In the geared locomotive the total weight is thirty-three tons, and the unspring-borne load is reduced to two-and-a-half tons per axle; in the multiple unit train, the weight of the motor carriage is twenty tons, and the unspring-borne load is still further reduced to one-and-three-quarter tons per axle.

The effects of the different types of trains are well shown in curves *a*, *b*, *c*, of Fig. 4, which correspond to the ordinary locomotive, the geared locomotive, and the multiple unit train respectively. The vibrations produced by the trains are, in fact, roughly proportional to the unspring-borne load, for those due to the ordinary locomotive are more than three times as great as those of the geared locomotive, and more than five times as great as those produced by the multiple unit train.

The observations made on the different trains also prove that the locomotives are almost entirely responsible for the disturbances, for the passenger coaches were practically identical in all the trains, and the only vibrations that could, as a rule, be registered when the multiple unit train passed were those made by the motors at either end.

The chief practical results of the enquiry may therefore be summed up as follows:—(1) One method of lessening the annoyance would be to reduce the irregularities of the rail-surfaces; and, if a very high speed (say, of a hundred miles or more an hour) were ever employed, this improvement might become necessary. (2) But with the speeds at present customary, by far the simpler and more efficacious method is to reduce the unspring-borne load in the locomotives to less than two tons per axle.

ACROSS RUSSIAN LAPLAND IN SEARCH OF BIRDS.

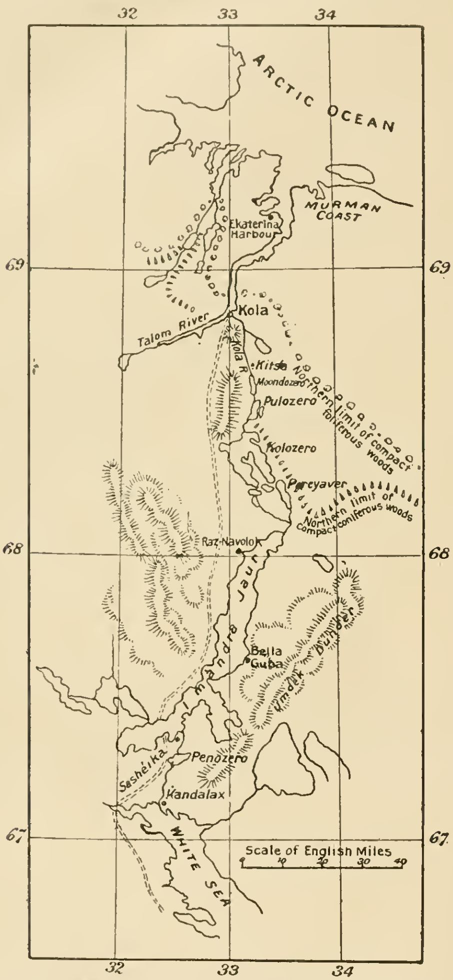
By HARRY F. WITHERBY, F.Z.S., M.B.O.U.

III.—FOREST, LAKE AND MARSH.

OUR first camping place in Russian Lapland was charmingly situated on the shores of a little lake the surface of which sparkled brightly in the sun, while behind us the river shone white and foaming every here and there between the birch and pine trees. There were a good many birds about. The golden-eyed duck,* the most numerous duck in this country, and very good eating, was plentiful but not easy to get. One which we shot fell in the water, and being caught by the stream flowing through the lake was hurled down the river at a furious pace. One of our men ran after it, but returned perspiring in half-an-hour or so, saying that it must by now have reached Kandalax. The pretty three-toed woodpecker,† which is much like our spotted woodpecker, but has only three toes, and a yellow head, was common, and although apparently not nesting was often to be found in a hole in a tree. Like our woodpeckers, these birds no doubt roost in holes of trees, and as we found them in these hiding places at all times of the day and night, we came to the conclusion that in these regions birds, like men, take their sleep just when they feel they need it. Other birds were about all night—the familiar cuckoo‡ was often to be

* *Clangula glaucion.* † *Picoides tridactylus.*
‡ *Cuculus canorus.*

heard at midnight, and Siberian jays* would wake us up with their harsh cries at one or two in the morning. These jays were not so large or so brightly coloured as the birds which worry our game-keepers at home, but they were most amusing. They used to come round our tent door while we were asleep and fight over the carcases of birds which had been skinned. Like English jays they were fond of imitating the notes of other birds, and one night



Sketch Map, showing route across Russian Lapland from Kandalax to Ekaterina Harbour.

we were waked up by a loud cry like a hawk. My friend snatched up his gun and, creeping to the tent door, shot the bird. Regardless of mosquitoes he went out with bare feet to pick up the "hawk." The mosquitoes drove him back at a run in no peaceful state of mind. "What was it," said I. "Jay," said he rubbing himself all over and beating the mosquitoes out of the tent with a towel. When the tent was clear and the mosquito curtain adjusted, I endeavoured to console my friend with the suggestion that the jay had fully atoned for its misplaced facetiousness.

As already explained we were forced to hurry through the country rather more quickly than we had wished owing to the difficulty of transporting and obtaining food. Had we not set our men to work to fish on every possible occasion, and had we not shot every eatable bird we could find our time would have been considerably shortened.

Luckily for us a certain amount of fish was always obtainable, and we made many a meal off salmon and salmon trout. It will shock the scientific fisherman to hear how we caught our fish, but we were not ashamed of poaching tricks because our time was fully occupied with collecting birds, and when we fished food was our only object and the quicker it was obtained the better. For instance, there were a fine lot of salmon in the little lake by which we first pitched our tent. As we rowed along this lake on our way north a line with a minnow at the end was let out. We soon had a 15 lb. salmon on, and he was quickly hauled alongside. We had no gaff handy, but a sheath-knife answered the purpose, and certainly the fish tasted very well when we fried him a few hours afterwards.

At the other side of the lake the river, swollen by melting snow and ice, was rushing down in a torrent so that we had to land and walk. While our men were loading up we found a lovely little dome-shaped nest of a willow-wren,* which is familiar in England as a summer resident, and is a great traveller for so small and slender a bird. The track, which led through very marshy ground, was composed of wooden "trottoirs," made of split logs laid down side by side. Wherever there was a track across boggy land in this country it was always made in this way, and when the logs were new walking was easy, but as often as not the logs were rotten or insecure. A loose log was annoying, and difficult to walk along gracefully, because the rounded side was laid on the ground, and an incautious step made it turn, and then there was disaster, especially when the bog was deep. At first we were always coming to grief on these "trottoirs," and our heavily loaded carriers disliked them exceedingly, although they were always quick to make merry over the misfortunes of others. However, experience teaches one even to walk along rounded planks over a marsh in safety, and in any case we consoled ourselves with the idea that these bogs were frozen not far below the surface. That such was the case we doubted afterwards, when several places had been tested unintentionally, and no bottom could be discovered.

During our first little walk over these "trottoirs" we saw many bramblings† in the birch trees about the track. These birds are only known in England in the winter, but in the north they may be said to represent the chaffinch, being very much like that bird in form and size, as well as in habits. The nests of the birds are almost identical, although perhaps the brambling's is not quite so neat as that of the chaffinch, while their notes are much alike. Another bird which continually reminded us of England was the red-spotted blue-throat.‡ This bird takes the place in these regions of our robin, to which it is nearly allied. It is very robin-like in its attitudes and movements, but instead of the red breast it has a shining blue throat with a red spot in the middle of the blue. This red spot distinguishes the northern blue-throat from

* *Perisoreus infaustus.*

* *Phylloscopus trochilus.* † *Fringilla montifringilla.*

‡ *Cyanecula suecica.*

its southern representative, which bears a white spot on its blue throat. The young bird has no blue on the throat, and its brown spotted plumage is much like that of a young robin.

Our walk ended on the shores of another small lake—the Penozero. Crossing this and marching again, this time through a pine forest, we reached Sashéika, where there is a "station" of two or three huts at the southern side of the great Imandra Lake. We were told here that the ice had cleared from off the lake only five days before we arrived (viz., on July 4th), so that all our delays counted little because we could not have proceeded further until the ice had left the lake.

At Sashéika we came across the first Lapps we had seen in this country. There were two very small men with fair hair and fair skin and two women with rather dark complexions. They lived in a small turf hut of the meanest

A Lapp Hut made of Turf.

description. During our journey across Russian Lapland we saw very few Lapps, as they leave the interior of the country during the summer and proceed to the coast for the fishing. At two places we found large Lapp villages of wooden houses entirely deserted. During this time of the year the reindeer are turned adrift, and most of them find their way to the coast or to high ground in order to escape from the swarms of mosquitoes which make the interior of the country unbearable for man or beast during the summer.

The few people we saw, whether Lapps or Russians, and the few animals, such as a dog or two and one cow, were utterly miserable owing to the mosquitoes and biting flies, and it is not surprising that the country is deserted even for this reason alone. The Lapps appeared to live almost entirely on fish and a sort of bread which is made from pounded birch bark with a mere sprinkling of flour. No vegetables can be grown in the country, and it is possible that this birch bark bread serves as a substitute. The huts of these people are extremely dirty, and those we examined were always strewed with fish bones and old reindeer horns.

Finding very few birds about Sashéika we soon decided to leave, and loading our baggage and ourselves into a small boat we started up the great lake, rowed by two men and two Lapp women, and steered by a Lapp man. We had got well into the middle of the lake when a thick fog came down and every landmark disappeared.

None of us wished to wander about the lake for hours in the fog, and the old Lapp at the rudder was sure he could steer to the shore, but no land appeared, and we soon discovered by a fishing line which we had out astern that his course was by no means straight. After a search in the baggage we found a compass which showed much to our amusement that the boat was describing circles. We tried to explain this to the Lapps, but they did not understand a compass. The fishing line, however, convinced all, except the old man who was steering, that we were not going straight. He was perfectly certain that he knew where he was going and refused to give up the rudder. Everyone in the boat began shouting directions to him, and it was some time before we could calm the people down and induce the old man to give up the rudder. As I knew that we wanted to go somewhere north I thought it safest to steer due north, and in about half an hour we reached the shore. As luck would have it there was a large rock which the Lapps immediately recognised just where we struck the land. It appeared that we had come on in the right direction, and even the old Lapp looked on me with suspicious awe.

According to Gregori they thought the rock was marked on the compass, but I rather think they suspected magic, because they could not understand how anyone could steer, especially in a fog, without a previous knowledge of the country.

While the fog lasted we spent the time in sleep, and the next day we rowed on and reached Bella Guba, where there was a telegraph station, a post house, and one other house, besides a few Lapp huts. Along the shores of the Imandra, ringed plovers* were nesting, while a few other birds such as Arctic terns and gulls, generally seen by the sea, were flying about. The dense pine forests which stretched away from the lake to the rocky hills beyond were distressingly destitute of bird life. Now and again one would catch sight of a capercaillie,† a Siberian jay, or a pine grosbeak,‡ but a walk in this dreary forest yielded little to compensate one for the torments inflicted by the mosquitoes. There were a few islands in the lake, but these were unproductive of birds, and we found that the marshes and the country just round them were the only really profitable places in which to spend our time.

We visited every marsh we could find or hear of near our route, and it was curious that while most of them contained many interesting birds, every here and there was one which was practically deserted, although apparently it differed in no way from the others.

All travellers in Lapland have something to say about biting flies, while a few in relating their experiences have been so led away by the subject that they have devoted a full two-thirds of their narratives to descriptions of mosquitoes and flies. Caution is therefore necessary in dealing with so tempting a subject, and I shall endeavour to confine my remarks on these interesting insects to the effect they had upon our work with the birds. Walking anywhere in a damp hot climate is somewhat of an effort, and soft mossy ground like most of that we had to travel over is notoriously tiring. Add to this the necessity of wearing continually thick gauntlets and a mosquito veil, and the conditions are not pleasant. But it was on the marshes that we were chiefly tried. There, mosquitoes and flies were in clouds, the damp heat was increased, and one sank knee-deep in moss and mire at every step. Under these circumstances, it will be understood that it took us

* *Aegialitis hiaticula.* † *Tetrao urogallus.*
‡ *Pinicola enucleator.*

some time to explore a marsh thoroughly. We shall never forget one awful day, just before a heavy thunderstorm, when we attempted to work a marsh, but found it quite impossible to go more than twenty yards without resting. A veil is a great handicap in shooting, and we found it exceedingly difficult to judge distance at all accurately. As to trying to watch birds in this country it was impossible to do so for any length of time. Directly one stopped, such a cloud of mosquitoes gathered round one's head that after a short time the bird could not be seen through the binoculars owing to the dense swarm of mosquitoes which quickly gathered in front of the glass.

The only times in which we were able to discard our veils was after we had beaten the mosquitoes out of the tent and fixed the curtain over the doorway, and when after rowing hard for half an hour or so on a lake we left the mosquitoes behind. At one place, however, we met a tiny black fly in such myriads that it became a far worse pest than the mosquitoes. This fly was so small that no ordinary netting would keep it out, and it crept into our hair and ears and bit so hard and unpleasantly that to escape going mad we were forced to pack up our things and run away from the place. But no one who has been in the interior of Lapland in summer can adequately describe the blood-sucking insects which possess that country.

As I have mentioned, the birds found on the marshes or bogs were the most interesting. They were chiefly wading birds, and many of them were well known to us as autumn

A Lake in Russian Lapland.

and winter visitors to the shores and mud-flats of the English coast. The most common of these were whimbrels* and wood sandpipers,† while greenshanks‡ and reeves,|| although not so numerous, were to be found on most of the marshes. All these birds appeared to have young ones, and in different ways showed intense anxiety for the safety of their broods. The whimbrels and greenshanks were always shy and cautious, keeping at a respectful distance and uttering loudly and incessantly their wild clear notes. It is remarkable that all these wading birds, when at their breeding stations habitually perch on the trees. The whimbrels used to perch on the tops of the fir trees, and fluttering their wings, perhaps to help keep their balance, would whistle defiantly at us. In the same way all the wading birds we found perched on the trees when disturbed.

* *Numenius phœopus.* † *Totanus glareola.* ‡ *Totanus canescens.* || *Machetes pugnax.*

Every marsh, and indeed every little bit of marshy ground, had a pair or two of wood sandpipers. Most fussy and noisy little birds they were, and so bold and tame that when once disturbed they were difficult to get rid of, and would follow one about so closely, crying anxiously all the while, that one's presence soon became known to every other bird anywhere near. It was curious that although reeves were as tame and almost as plentiful in some places as wood sandpipers, we never saw a single ruff, as the male bird of this species is called. The ruff is polygamous, and it is well known that it keeps apart from its harem when the young are hatched, and takes no share or responsibility in the troubles and anxieties connected with its offspring. Had there been any ruffs in the country we explored, I think it hardly likely that we should have missed them, so we must conclude that they had entirely deserted their families and had already gone south towards their winter quarters.

From Bella Guba we rowed up the Imandra to Raznavolok near the northern end of the lake, and on some marshes near there we made our best finds. Hitherto we had found birds in this country by no means plentiful, and we had been much disappointed by the dearth of bird-life in the enormous pine forests as well as on the large lakes. We were delighted, therefore, to find a great many interesting birds breeding on these marshes. Two of these, the bar-tailed godwit* and the dusky redshank,† especially attracted our attention, because it had been the privilege of but a very few ornithologists to see these birds in their breeding haunts. On arriving at the largest marsh, which was a five-mile trudge from our camp, we arranged to work it systematically. However, we had scarcely gone a hundred yards before a strange bird rose from the ground. We shot it and found with delight that it was a male bar-tailed godwit in the beautiful summer plumage—a dark black-brown back and a rich salmon pink breast. A long search near the place from which the bird had risen was unproductive—neither its nests nor the eggs or young could be found. Then we began to search the marsh rather excitedly, and some way off we put up the female—not nearly so brilliant a bird, with a buff rather than salmon-coloured breast. Still we could find neither eggs nor young, but at this we were not very surprised, as these marshes or bogs are profusely overgrown with a multitude of creeping plants, such as dwarf birch and many kinds of berry-bearing plants besides thick moss and grass. That day we found many other birds but saw no more godwits. On the next day, however, we carried out our plan of a systematic search and were successful in finding two more pairs of godwits. The male bird of one of these pairs was evidently in charge of young ones. He flew round us in a very excited way, and although he did not hover about quite near us, like the sandpipers and reeves, he often swooped over our heads with a rush and then retired to a tree-top and quivered his wings and called loudly. We kept as quiet as the flies would allow, and after a time I saw four young birds running on the ground at some distance. I rushed madly to them; they separated, and I managed to keep only two in view. These I caught, but the other two had hidden themselves so cleverly and quickly that although we knew just where they must be we could not discover them, and of course nothing would make them budge now that danger threatened. Young birds which run as soon as

* *Limosa lapponica.* *Totanus fuscus.*

they are hatched know well the value of lying flat and keeping as still as stones. My friend afterwards found a brood on another marsh, but these he failed to catch. In each case the male bird was evidently attending to the young as the female was found at some considerable distance. These young godwits were only a few days old, and were beautifully clothed with soft down. They were great prizes, and, as far as I know, were the first young in down of the bar-tailed godwit to be obtained, although Mr. H. L. Popham has told me that he had seen them on the Yenesi in Siberia but had been unable to secure any.

The dusky or spotted redshanks which we discovered on several marshes were an even greater find than the godwits, because since the days of Wolley, fifty years ago, our knowledge of their breeding haunts has scarcely increased. Unfortunately, however, we were unable to discover either eggs or young of these birds notwithstanding hours of watching and searching. One day I watched a pair for two hours without success, so wary were the birds. When I was in view they flew wildly about uttering an incessant rattling alarm note. Then when I got well hidden they kept quiet, and my hopes of their visiting the nest or young revived. I waited. Meanwhile the mosquitoes gathered in thicker and thicker swarms. My veil getting disarranged touched the back of my neck, and immediately a cluster of mosquitoes settled on the place. A slight exclamation and an incautious movement were impossible to prevent, and the ever-watchful redshanks saw me and began their fuss and clamour again. I had to change my hiding-place and wait again, but the mosquitoes and the redshanks always got the best of it in the end, and at last I came to the conclusion that my patience was insufficient for the task.

The majority of wading birds have a larger and richer plumage in summer than in winter, and these redshanks were of a very handsome sooty-black colour spotted with white. Their beaks were dark, but their legs were of a rich crimson, which looked very bright against their black breasts.

To find these two species in their breeding haunts was especially interesting to us, because both birds visit the shores of England on their migrations in spring and autumn.

VEGETABLE MIMICRY AND HOMOMORPHISM.—III.

By Rev. ALEX. S. WILSON, M.A., B.Sc.

QUITE a number of flowers have distinctly mimetic odours. It can hardly be doubted, for example, that the offensive smell of the carrion flowers *Stapelia, Aristolochia, Arum, Rafflesia*, and others, is more effective in promoting cross-fertilisation because of its resemblance to the odour of putrid meat. So completely are the flesh flies deceived that they often deposit their eggs on the petals of carrion flowers.

Fœtid odours occur in *Bryonia, Helleborus, Geranium, Stachys, Ballota, Iris*, and other genera. The odours of others have a curious resemblance to the smells emitted by certain animals. *Hypericum hircinum* and *Orchis hircina* are bad smelling flowers with an odour resembling that of the goat; *Coriandrum sativum* has the fœtid smell of bugs, while the hemlock, again, emits a strong odour of mice. Along with these may be mentioned *Adoxa*, the musk orchis, the grape hyacinth and other musky scented flowers.

The resemblance in smell between these flowers and the secretion formed in the scent glands of the musk ox and other animals is, to say the least, a remarkable coincidence. Possibly flies which accompany cattle may be attracted by smells of this description. Very curious also is the vinous smell of *Œnanthe*, and the brandy-like aroma of the yellow water lily *Nuphar*, hence called the brandy bottle. Ethereal oils exhaled by plants while attractive to some animals seem to repel others; the scents of sweet-smelling flowers such as *Daphne, Thymus, Marjoram, Melilotus*, and *Gymnademia*, though grateful to bees and butterflies, appear to be distasteful to ruminants. Kerner states that in general the latter avoid all blossoms; even caterpillars do not readily attack the petals of their food plants. Odour may therefore be protective or attractive or it may be of use in both ways. The same remark applies to colour, which may serve either to attract or repel; the richly-variegated leaves of the Indian nettles—species of *Colleus*—and the tinted foliage of *Begonia* and *Geranium* may possibly escape injury on account of the general resemblance to coloured blossoms. Instances in which one plant resembles another in smell are not very common in the flowering class, though cases do occur like the garlic mustard and apple-scented *Salvia*. Resembling odours are much more frequent among fungi.

Characteristic examples of homomorphism are seen in the resemblances which many species of Euphorbia present to the Cactus tribe and in the pollen-masses of the Orchids and Asclepias. In Britain the order Euphorbiaceæ is represented by the box, dog's-mercury and the sun-spurges, but many foreign species have quite a different appearance and agree with the Cacti in their

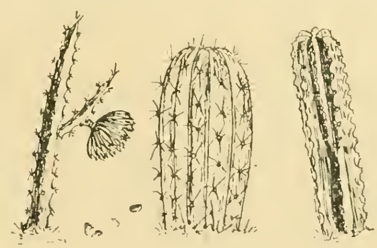


FIG. 10.—Cactus and Euphorbia.

aborted leaves and green succulent stems. The globular, columnar, and angular forms give to both a peculiar aspect by which they are broadly distinguished from all other vegetable types; and yet in systematic position these two orders stand far apart. The nearest affinities of the Euphorbiæ are with the Urticaceæ and other orders having incomplete flowers, while the nearest allies of the Cacti are the Cucurbitaceæ and other calycifloral orders. Succulent stemmed plants of this description are specially adapted to an arid climate, and it is not unreasonable to suppose that the similarity between the Euphorbiæ and Cacti results from the long-continued action of similar external conditions upon similarly endowed tissues.

Sir W. T. Thiselton Dyer, in a paper on "Mimicry in Plants" (British Association, 1871), adduces as examples of homomorphism, or as he terms it, homoplasm, a climbing composite of South America, *Mutesia speciosa*, having the leguminous habit and closely resembling the European *Lathyrus maritima*; three ferns, natives of different parts of the world, which are indistinguishable in the barren state; and a species of Veronica in New Zealand; the latter so resembles a coniferous plant that it misled Sir W. Hooker.

The Australian Casuarinas are dicotyledons with incomplete flowers nearly related to the oak, hazel and other Cupuliferæ, but in outward appearance they have a singular resemblance to the horse-tails, a family of Cryptogams. One of the Gymnosperms or cone-bearing class, Ephedra, also presents the same jointed appearance so characteristic of Equisotaceæ. Growing in marshy places very like those affected by Equisetum we find the mare's-tail Hippurus, a flowering plant allied to the fuchsia family, but externally resembling Equisetum in its jointed stem and whorled leaves. A familiar instance of the same kind of homomorphism is Equisetum sylvaticum, which might almost be described as a Lilliputian fir-tree. The little flowers of the water ranunculus look exactly like miniature water lilies, while the leaves and flowers of Caltha palustris simulate the yellow Nuphar so much that in some parts of the country the marsh marigold is known as the water lily. The specific name of another aquatic, *Lymnanthemum nymphæoides*, indicates a peculiarity of the same kind. Leaf analogies are frequent among aquatic plants; the orbicular, peltate leaf of the Indian cress occurs, for example, in Hydrocotyle, Nelumbium, and others. The brown colour and translucence of Potamogeton, Myriophyllum, and other aquatics assimilates them to the fronds of Laminaria and other sea-weeds.

A grass-like habit is assumed by some plants. This character is attained in the meadow vetchling by the arrested development of the compound leaves and the great elongation of the stipules. *Lathyrus nissolia* has the stipules minute, but the phyllodes or leaf-like petioles impart the grass-like character. A moss-like habit occurs in a great many plants belonging to very different families; thus the wiry stem of the purging flax reminds one of the seta of Polytrichum. The pearlwort of the walls, many alpine saxifrages, pinks and gentians present very much the appearance of mosses, *e.g., Silene acaulis, Saxifraga bryoides, S. hypnoides, Arenaria Cherleri*, etc. The sub-species Saxifraga geum is another instance of leaf analogy. The generic name Pyrola implies a fancied resemblance of the leaves to those of the pear tree. Certain leaf-types frequently recur, the rough broadly tongue-shaped leaf of the bugloss, for example; hence the very common specific appellation *echioides*. The nettle-leaved bell-flower reproduces the foliage of Urtica and the sinuate leaf of the oak appears in several families.

Parasitic phanerogams like Rafflesia commonly exhibit the fungoid character in a marked degree. In their internal structure, colouring, spore-like seeds and other characters they approximate closely to the fungi.

As examples of homomorphism between closely allied plants may be mentioned the false oat, which so strikingly resembles the cultivated species, and the barren strawberry which agrees so closely with the cultivated strawberry of our gardens.

Although it is only under exceptional circumstances that a flower is likely to mimic another blossom closely, vague general resemblances are not uncommon, such as that between the rock-rose and the buttercup, between the milkwort and the vetch, and between Veronica and Valerianella. A more decided likeness is that of the garden annual Collinsia to the butterfly blossoms of the pea tribe. This case is peculiarly instructive since the homomorphism can be traced to its cause. The butterfly-like corolla of Leguminosæ seems to have afforded the pattern after which a number of flowers have been fashioned. The Papilionaceæ are adapted to bees rather than to butterflies or moths, and the pollen is applied to the ventral surface of the insect, the essential organs being lodged in the carina or pouch formed by the two lower petals. Among the Scrophulariaceæ to which Collinsia belongs, the pollen is commonly sprinkled on the back of the insect and the stamens are contained in the upper lip of the corolla; Collinsia is, however, exceptional; the stamens are lodged within the lower lip of the flower and the pollen is applied to the ventral surface of the bee. Here the resemblance is evidently an indirect result brought about by the flowers of Collinsia having become adapted to the same class of visitors as the Papilionaceæ, viz., bees which have their brushes or baskets of hair for collecting pollen attached to the abdomen. Where two flowers are very like insects are apt to mistake the one species for the other, but this will not involve any loss if there is an interval between their periods of blossoming.

Homomorphic likenesses are not confined to homologous organs; an organ of one plant sometimes exhibits a very perfect resemblance to a different organ on some

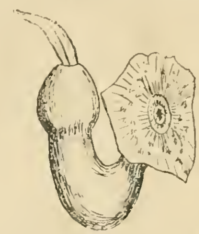


Fig. 11.—The Dutchman's Pipe *(Aristolochia sipho)*.

other plant. Thus *Aristolochia sipho*, the Dutchman's pipe, so-called from the appearance of its flowers, has a perianth singularly like the leaf-pitchers of Nepenthes, and the curious little nectaries of Nigella might almost be compared with the pitchers of the Australian insectivorous plant Cephalotus. As the Aristolochias imprison small dipterous insects in their flowers these instances favour to some extent Henslow's idea that

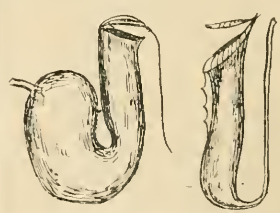


Fig. 12.—Flower of *Aristolochia trilobata* and Leaf-pitcher of Nepenthes.

Fig. 13.—Pollen-masses of Orchid and Asclepiad.

both flowers and pitchers have arisen by hypertrophy caused through the irritation set up by insects.

The homomorphism of the Orchids and Asclepiads is specially interesting because of the objection to the Darwinian theory that it presents; the coincidence is certainly unfavourable to the notion of fortuitous variation. The orchids and asclepiads agree in producing pollinia or pollen-packets which attach themselves to the bodies of insects and are thus transferred from flower to flower. Although the two flowers differ greatly in the details of their structure, this curious contrivance occurs in no other plants, and yet the two orders are as widely separated as it is possible to conceive. The orchids belong to the petaloid division of Monocotyledons; the Asclepias to the gamopetalous Dicotyledons, with their nearest allies among the Apocynaceæ, of which Vinca, the periwinkle, is perhaps the best known representative. Although agreeing in this one particular the flowers are in other respects very dissimilar.

FIG. 14.—Flower of Ceropegia.

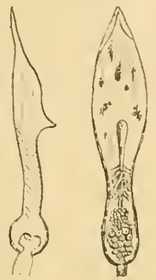


FIG. 15. — Birthwort and Cuckoo-pint showing mouse-trap hairs.

Another contrivance for promoting cross-fertilisation met with in unallied plants is the mouse-trap arrangement of hairs by means of which small flies are temporarily imprisoned. This arrangement occurs in Aristolochia, in species of Arum, and in Ceropegia, one of the Asclepiads. In these plants where the affinities are so slight the mechanism for fertilisation must in each case have arisen independently.

ASTRONOMY WITHOUT A TELESCOPE.

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

XIV.—SUNSPOTS AND MOONSPOTS.

THERE are only two of the heavenly bodies which present a disc to our ordinary sight, and the surfaces of which therefore we can study without a telescope. These are the sun and moon. It is, of course, absolutely impossible that observations thus made can in any way compete with those made even with a hand-telescope; but from the point of view of astronomical drill, as distinguished from actual research, there is something to be said for systematic work upon both of them. Jupiter as seen with a magnifying power of 50, Mars at a mean opposition with one of 100, Saturn with a similar magnification, present about the same apparent disc as the sun and moon do to the naked eye. There is therefore a real interest in seeing how much detail the eye can actually detect upon these two bodies. The limit of magnification possible for the efficient study of the surfaces of the planets is soon reached, and when an astronomical artist has done his very best with Jupiter, Mars, Saturn or Venus, it would be an invaluable check upon his work if he would draw the sun or moon with a little instrument, and such small magnification as would give to its disc the same apparent diameter as had been presented to him by the planet which he had just been studying. The "Bulletin de la Société Astronomique de France" for 1900 contains a large number of such drawings of the moon, made with the naked eye, and the study of them is, I think, most instructive on a number of points which have been in dispute from time to time as to the condition of the surface of Mars.

The defining power of the eye is, of course, limited, and when a number of details are presented to it, each one of which is much too small to be defined separately, all together produce a composite effect to which each detail has contributed in its own degree. Now there certainly is a wide

NORTH.

EAST.

WEST.

SOUTH.

Photograph of Moon, taken 1902, March 22, 10h. 37m. 24s. G. M. T.

difference in the manner both in which such composite effects will impress different persons, and in the way in which they will record them in a drawing. And the study of the "personality" of astronomical artists should be a necessary precedent of the comparison and collation of their drawings. The drawings of the moon, given in the volume referred to above, are as widely different as any set of drawings that were ever made of Jupiter or Mars. Yet a careful comparison of them with maps or photographs of the moon will show that the forms given are not imaginary, but have a real relation to the lunar markings, whether they be skilfully represented or no.

The following drawings are from the volume cited, pages 277 and 505, and are by M. Maurice Petit and M. E. M. Antoniadi respectively. The latter comments on his observations as follows:—

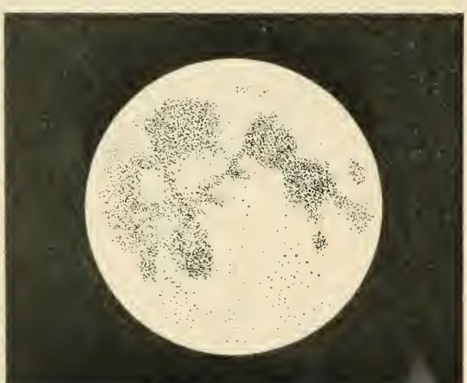
"It is a work of immense difficulty to draw correctly all the "details that the naked eye reveals to us on the surface of our "satellite. It is above all things necessary that the moon should "be seen with the greatest possible distinctness. If the eye is not "emmetropic it will be necessary to select glasses of the proper "focus bringing the focus *exactly* on the retina. The accom- "panying sketch which is only a rough approximation was obtained "with concave glasses, allowing at least ten stars to be seen in the "group of the Pleiades; it is the result of studies covering several "lunations. . . . . The darkest spots seemed to me (1), the Mare "Tranquillitatis, and (2) Mare Nubium. The Mare Serenitatis and "Fecunditatis come next. Mare Imbrium and Oceanus Procel- "larum are still paler. The little Maria Crisium, Vaporum, Humorum "and Nectaris, are reduced in size by irradiation, and present to the "naked eye an appearance corresponding to that of the Lacus Soli- "and Lacus Lunæ of Mars as seen in a telescope. The white spots "of Copernicus and Kepler are very well seen, Aristarchus with "more difficulty, whilst Tycho, with its brilliant surroundings, "occupies an immense white surface; but . . . . the ring itself "is not seen. Gueriké, Bonpland, Parry and Fra Mauro make up "a bright island in the Mare Nubium. Lastly, the Mare Serenitatis "is whiter in the centre by reason of the great white streak coming "from Tycho which crosses it."

With regard to the sun, it may be thought that absolutely nothing can be done without optical assistance. But any

A, Mare Crisium. B, Mare Foecunditatis. C, Maria Nectaris et Tranquillitatis. D, Mare Imbrium. E, Oceanus Procellarum. F, Mare Humorum. G, Mare Nubium. H, Apennines and Copernicus.

Drawing of M. Maurice Petit.

observer who will give himself day by day to its patient scrutiny will be astonished ere long at the result. Of course, in this case, the term "naked eye" is no longer applicable, since the eye must be shielded from the overpowering light of the sun either by a dark glass or the sun's light may be admitted through a small hole into a darkened chamber and received upon a white screen. But thus observed the sun at maximum activity will show a spot large enough to be *easily* seen on fully one day in



Drawing of M. Antoniadi.

four; not infrequently two or three spots may be seen at the same time. Had it occurred to the classical and mediæval astronomers to watch the sun systematically in this way, they would not only have detected the existence of spots on its disc, but have demonstrated as certainly as we know it to-day the period of the sunspot cycle, and the value to us of that information would have been incalculable. More than that, it would have been possible for them, from a long series of observations, to have fixed the solar rotation period fairly exactly and to have made a first approximation to the determination of the position of the axis.

The accompanying little table and diagram give a comparison between the number of days in each year during the last two decades in which there were spot groups the

Year.	No. of Days on which Spot-groups exceeding one-thousandth of the Sun's disk were visible.	Mean daily spotted area expressed in millionths of the Sun's visible hemisphere.
1882	78	1002
1883	129	1155
1884	91	1079
1885	68	811
1886	35	381
1887	17	179
1888	3	89
1889	3	78
1890	8	99
1891	32	569
1892	99	1214
1893	135	1464
1894	112	1282
1895	82	974
1896	58	543
1897	52	514
1898	42	375
1899	9	111
1900	1	75
1901	5	29

area of which as seen covered more than one-thousandth of the sun's apparent disk, and the mean daily spotted area expressed in millionths of the visible hemisphere as deduced from the photographic record at Greenwich. It will be seen that the first record comes as sharply to a maximum as the second, and falls off again as unmistakably to a minimum. Even the minor details of the second curve are faithfully indicated in the first. The limit chosen—one-thousandth of the visible disc, or almost

NORTH.

EAST.

WEST.

SOUTH.

PHOTOGRAPH OF THE BELT AND SWORD OF ORION.

Taken by A. Smith, Dalbeattie, on 2nd February, 1902. Exposure 2 hours 40 minutes.

exactly the apparent size of Venus in transit—would not in all cases correspond precisely to the limit for the visibility of spots. Specially dark and compact spots have been distinctly seen even when only of one-half this size; faint or scattered groups might escape notice even if a little larger; but general experience has shown that the limit selected corresponds very nearly to the limit of visibility without optical assistance, differing from it in under-stating, not over-stating, the number of groups which could be seen.

Of course, there is no possibility now for the "Astronomer without a Telescope" to improve on the information which the telescope can give us as to solar physics, but the lesson which the foregoing table has to teach is a most important one. Observations, as difficult and as apparently hopeless as observations of the solar surface would have seemed to be in the Middle Ages, may, if carried out patiently and systematically, bear as rich fruit as solar observations could have done even then. Even after the invention of the telescope, it was not the optical power of his instrument, but the perseverance with which he worked at a single object which revealed to Schwabe the secret of the solar period. He had no dream of the discovery before him when he set out upon his researches. His own expression was that he "set out like Saul, looking for his father's asses, and found a kingdom." There are kingdoms yet to be won, even in those fields of astronomy which the telescope cannot touch. In particular, changes which are periodic in character will reveal the fact and circumstances of that periodicity to observations carried on patiently and continuously, even when the amount of such changes at their maximum only just come within the utmost limits of the power of the instruments used in the work.

THE BELT AND SWORD OF ORION.

By Alexander Smith.

The photograph of which the accompanying plate is a reproduction—enlarged to about 2 diameters—was taken on February 2 last with an exposure of 2 hours 40 minutes, the lens used being a $5\frac{1}{4}$-in. Voigtländer doublet of 22 inches focus. The camera was attached to the tube of a $12\frac{1}{4}$-in. reflector, which was utilised as a guiding instrument, while the driving power was furnished by a three-pendulum turret clock, whose motion is so regular and certain that very delicate photographic work can be undertaken without risk of failure resulting from any unsteadiness of the driving mechanism.

The development of the plate was prolonged as far as possible with the view of bringing out faint stars, and, although this treatment has obscured all detail in the brighter portion of the Great Nebula, there is little difficulty in tracing on the original negative almost the whole of the fainter outlying wisps of nebulous matter shown on photographs, which have been secured, not only with exposures of longer duration, but with much larger apertures. A comparison of the photographs of this object, which have been published from time to time, shows that the whole region of the nebula exhibits more or less of structure, and the result of a number of experiments I have carried out recently would seem to indicate that satisfactory impressions of such details can only be obtained on a single exposure by departing from the methods of development usually adopted.

Another interesting nebulous region in the constellation of Orion is that surrounding the star Zeta. Following this star is H. V. 28, which is made up of several well-defined patches separated by dark rifts in which there is very little trace of nebulous material. Stretching southwards from Zeta for about a degree is a straight band of nebulous matter, which, although exceedingly difficult to detect visually, can hardly fail to be noted on negatives obtained with fairly long exposures. In the *f.* edge, which is well defined, is a very prominent gap somewhat resembling the "fish-mouth" in the Great Nebula. In the same region there are several nebulous stars. 23 min. south of H. V. 28 is H. IV. 24, and about a similar distance *f.* is another and smaller nebulous star. About 25 min. north of Zeta is a third object of the same class. These can easily be traced on the negative, while a fourth, about 11 min. preceding the last named, is shown on a recent photograph taken by Mr. Henry Ellis with a $20\frac{1}{4}$-in. mirror. Only one of these objects is recorded in the N.G.C., and the region would appear to be worthy of further investigation by those having large apertures at their disposal.

Letters.

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

FAHRENHEIT'S THERMOMETER.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The description which I gave of Fahrenheit's thermometer was merely the result of my enquiries, and was intentionally brief, as I feared to overload your valuable columns. It has called forth the criticism of Mr. Cleveland Abbe, of the Department of Agriculture at Washington, who throws doubt on the statement that Fahrenheit was indebted to Newton for his scale. It is true that neither in Fahrenheit's biography, or indeed in any work of the time, is there any distinct account of the rationale of his scale; for had it been otherwise an explanation of it would have appeared in works of chemistry, the authors of which profess ignorance of its meaning. It is clear, therefore, that what is known can only be gathered by inference from writers who have interested themselves in the matter, and these, as far as my reading has gone, have attributed to Newton the origin of the scale. Mr. Cleveland Abbe gives the figures of these two celebrated men as I have done, and it seems a most remarkable coincidence, should they both have started from the same point between freezing and boiling, and adopted the same number, that they should have done so from perfectly independent considerations. It would be remarkable too, if Fahrenheit had never seen or heard of Newton's instrument, invented a few years before. We have only to multiply Newton's figures by eight, for the reasons already given, to obtain Fahrenheit's scale. The scale of the latter, as your correspondent says, in his first constructed thermometer, was plus 90 and minus 90, but it is not clear how this could have assisted in the framing of his subsequent scale, as the numbers did not refer to freezing or boiling points. That thermometer, as is known, he discarded, and then made another, taking for his fixed point the temperature of the human body. This was Newton's method, by which he had worked. It seems to be correctly said that Newton was in doubt as to a fixed point for boiling, for he speaks of boiling and violent boiling, as if they implied different degrees of heat.

Newton's paper appeared in the *Philosophical Transactions* for 1701, and although anonymous has always been attributed to our great philosopher. It is so said by Brewster, by Kelvin, by Renou and others. Newton begins by saying that he used linseed oil in a glass tube, and gives a table showing the height on his instrument at which the different liquids boiled—

"In hujus tabulæ columna prima habentur gradus caloris in proportione arithmetica computum inchoando a calore quo aqua incipit gelu rigescere tanquam ab infimo caloris gradu seu commune termino caloris et frigoris, et ponendo calorem externum corporis humani esse partium duodecim.

"Patet autem per hanc tabulam quod calor aquæ bullientis sit fere triplo major quam calor corporis humani.

"Ex his inventis ponendo calores olei ipsius rarefactioni proportionaleset pro calore corporis humani scribendo partes 12 prodiit calor aquæ ubi incipit ebullire partium 33."

(In the first column we have that degree in which water begins to freeze as the lowest degree, making the external heat of the human body to be 12 degrees. Now it is evident from this table that the heat of boiling water is almost three times that of the human body, being 33 degrees.)

In the article on heat in the *Encyclopedia Britannica* by Dr. Mill, late Librarian to the Royal Geographical Society, the writer mentions the paper by Newton, and then describes the thermometer by Fahrenheit, who took his predecessor's scale as his improved standard. After writing this, I had an interview with Dr. Mill, who informed me that from the researches he made at the time of writing his article he certainly came to the conclusion that this was the case, that Fahrenheit copied Newton.

I also enquired of Mr. R. H. Scott, F.R.S., the late Secretary of the Meteorological Council, and he gave me a paper he had written in 1884 in which he says: "We next come to Newton, and in the *Philosophical Transactions* for 1701 we find a paper, certainly from his pen, on the scales of thermometers, and in it he announces that his instrument, filled with linseed oil, is marked 12 at the temperature of man's blood. This is the first notice we possess of a blood heat 'on the scale.' Fahrenheit began by using a scale of minus 90 and plus 90 blood heat. This scale he soon gave up, by Boerhaave's advice, for one with 24 for blood heat. He then divided these degrees into quarters, and this gave him 96 for blood heat. Carrying on his researches he found that water boiled at 212. Such was the origin of the famous Fahrenheit scale."

In the *Philosophical Transactions* for January, 1724, is a short paper, entitled "Experimenta circa gradum caloris liquorum nonnullorum ebullientium instituta; a Daniele Gab. Fahrenheit." The author alludes to the experiment of another chemist, that water boiled at a fixed point (fixo gradu 212°). This he himself confirmed, as well as in most other liquids of which he gives a table. He used mercury as it answered so well in the barometer. I believe most authorities give Fahrenheit credit for first using mercury for a thermometer.

Now I may mention Renou, to whose opinion Mr. Abbe evidently attaches much importance. He says:—

"On trouve dans les *Philosophical Transactions* pour 1701, un article anonyme mais qu'on sait être de Newton. "L'echelle des degres de chaleur."

"Cette article donne les points de fusion et d'ebullition d'un grand nombre de corps, evalués avec un thermomètre à l'huile de lin qui marquant 0° a la temperature de congelation de l'eau, 12° à la chaleur du sang humain, et 34° a la plus violente ebullition de l'eau. C'est le première indication que je trouve dela chaleur du sang de l'homme: on attribue ordinairement à Boerhaave la decouverte de la fixité de cette temperature; je ne sait si ce fait est certain." "Nous avons dit tout a l'heure que Newton avait evidemment pris pour l'un des points fixés de son thermomètre la temperature de sang humain; nous allons voir que, pendant longtemps cette temperature joue un role important." M. Renou then mentioned Fahrenheit's first thermometer, and goes on to say, "Fahrenheit abandonna biéntot cette echelle d'apres les conseils de Boerhaave peut-etre et adopta peu de temps avant 1714 une echelle qui ne comportait que 24° comprenant le meme intervalle que son premier thermomètre. Peut-etre Fahrenheit n'avait il pas voulu d'eloigner trop de la division de Newton, mais pour un intervalle plus grand il dut choisir un nombre de divisions double."

[We find in the *Philosophical Transactions* for 1701, an anonymous article known to be Newton's, on the scale of heat. It gave the boiling point in a number of liquids by a linseed oil thermometer, beginning with freezing, making blood heat 12 and boiling water 34. This is the first indication of the heat of the human blood, and this for a long time played an important part. Fahrenheit abandoned his earliest thermometer, and not wishing to depart from Newton's division made blood heat 24.]

Samuel Wilks.

THE VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Allow me to refer your two correspondents on the above subject to a paper of my own in the *Journal of the British Astronomical Association*, Vol. XI., p. 339, where they will find Stoddart's alleged observations discussed, and, I think, will conclude that Mr. Maunder does that gentleman no injustice in not accepting his claims as proved.

But I think that in the note in Knowledge the powers of sight required for different observations are not sufficiently differentiated. The ability to see eleven stars in the Pleiades, and to pick up Vesta and Uranus, or to see Venus at mid-day, is of a different order to the ability to divide ϵ_1 and ϵ_2 Lyræ, to define the crescent of Venus, or see the satellites of Jupiter. Of course both abilities may be possessed, as in Mr. Maunder's case, by the same individual, but this is not necessarily so.

I shall be glad to know under what circumstances Jupiter's 2nd satellite can be elongated nearly 4′ of arc. I cannot make it more than 206″ from the limb, and this only in opposition. Although this is about the same distance as ϵ_1 and ϵ_2 Lyræ, I think the great difference of magnitude of Jupiter and II. makes the separation a very different matter indeed.

As regards Mr. Rodgers' instance of the visibility of the crescent of Venus, it is defective in the same way as are most of the astronomical feats of this kind, in that neither date, hour, nor place is given, while it is also anonymous. It has convinced *him*, but it cannot be held sufficient to convince others. Besides, most people are aware that the crescent of the moon is convex towards the sun, and would naturally see the crescent of Venus in the same way if the observation was entirely imaginary, and when shown the crescent reversed in the telescope would find it contrary to their anticipations. I believe nine persons out of ten who think they have good sight would see the crescent if one asked them, if reminded it was convex to the sun.

But Venus would be represented by a crescent $\frac{1}{300}$ of an inch long at 10 inches from the eye, or a fourth of an inch at 62 feet. Can any eye make out the shape of such a brilliant crescent? yet Venus would be seen under less steady conditions than such near crescents.

I have only been able to obtain exact date and hour of *one* alleged observation of a satellite of Jupiter with the unaided eye, and on investigation it turns out the planet was about three weeks past quadrature at the time.

The visibility of the crescent of Venus can be experimented upon indoors. Let a crescent 1 in. from cusp to cusp be cut out of card, and illuminated by a lamp placed behind it. Nine feet away place any polished convex surface, and view the reflected crescent in this at fifteen times the radius of the surface, or the crescent moon will answer the same purpose as the card crescent. The radius of the reflecting convex is not of importance so long as the observer is fifteen times that radius away.

Edwin Holmes.

[I thank Mr. Holmes for drawing my attention to the paper to which he refers. I had missed it, as it appeared during my absence in Mauritius. I gave the particulars respecting my own eyesight merely to show that it was not due to any inferiority in it as compared with average sight that I have always failed to define the crescent of Venus. Anyone who has done so must have sight *several times* as good as mine ever was. The maximum elongation of Jupiter II. from the centre of the planet is "almost four minutes of arc" if Jupiter be in opposition and at perihelion at the same time. Thus its elongation was 3′ 54″ on 1880, October 6.—E. Walter Maunder.]

THE USE OF HAND TELESCOPES IN ASTRONOMY.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—May I suggest that the remarks respecting Jupiter and Saturn, on page 81, are somewhat misleading. No note is made as to the visibility of details being affected by the declination of the planets. As long ago as 1861, "Recreative Science" contained (under a *nom de plume*) some observations of mine made with a $1\frac{1}{2}$ in. telescope. With this the crape ring was often seen where it crosses the ball, while Jupiter's belts could not be overlooked. But in 1861 both planets, especially Jupiter, had considerable northern declination. F. W. Levander.

30, North Villas, Camden Square, N.W.

Conducted by W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U.

Bird Migration.—The *Ibis* for April contains a most valuable contribution to this most fascinating study, by Mr. W. Eagle Clarke, one of our greatest authorities on the subject. Mr. Clarke's observations were made during a month's stay in the famous Eddystone Lighthouse. Deciding that the autumn was the best season for observation, he took up his residence on the 18th September, and left on the 19th of October, 1901. Cloudless and moonlight nights were singularly unproductive, not because no passage-movements took place but because they were beyond the range of observation. The most successful nights were those when the atmosphere was saturated with moisture (rain, haze, cloud). This mixture "becomes more or less opaque, while the powerful beams, streaming out from the lantern upon it, become luminous and brilliant to a very remarkable degree, and exert extraordinary attractive powers over the migrants that pass within their sphere of influence." The main factors in migration movements, Mr. Eagle Clarke points out, are not the winds, but certain systems of atmospheric pressure which establish fine weather-conditions in the North Sea. The winds are the result of these pressure systems, and appealing more to the senses, have come erroneously to be regarded as the principal cause of migratory movements.

Male Birds in Female Plumage.—The *Field*, April 26th, contains a short but interesting article on this subject by Mr. W. B. Tegetmeier. The author points out that there are breeds of game fowls in which the males habitually wear the female attire, and are known in consequence as "hennies." No less fertility or courage follows the change of livery; on the contrary, "hennies" were remarkable as being the most dangerous birds in the cock-pit. The origin of these hen-feathered birds, Mr. Tegetmeier attributes "to an accidental variation, of the causes of which, like those of other variations, we know absolutely nothing."

Rooks with Feathered Faces.—In a letter in the *Field*, May 3rd, it is suggested that Rooks with feathered faces are becoming more common on account of changed habits, the Rook having largely relinquished its habit of digging for food in favour of egg-stealing. This question has been raised and discussed before. So far the evidence seems to lend little support to this theory, but rather to suggest a reversion to the conditions common to all the members of the family save the Rook.

Penguins at the Zoological Gardens.—It may interest our readers to know that an unusually fine collection of these birds can be seen at the Gardens at the present time. The species represented include three King Penguins *(Aptenodytes pennanti)*, the Black-footed Penguin *(Spheniscus demersus)*, Sclater's Penguin *(Catarrhactes Sclateri)*, and the Thick-billed Penguin *(C. pachyrhynchus)*.

Bird-Life in Norway.—*Land and Water*, April 26th, contains an exceedingly interesting article on bird-life in Norway. The bulk of this is a translation of a paper by Prof. R. Collett. Those of us who cannot read Norwegian should be grateful to the translator, for much valuable information has now been made accessible concerning the breeding habits of a number of cliff-haunting species.

All contributions to the column, either in the way of notes or photographs, should be forwarded to W. P. Pycraft, *at the Natural History Museum, Cromwell Road, London, S.W.*

NOTES.

Botanical.—An interesting paper on abnormal fruits—a melon in which the seeds had precociously germinated, and an orange, which showed pleiotaxy of the gynaeceum—appeared in the March number of the *Annals of Botany*, contributed by Sir W. T. Thiselton-Dyer. The melon when cut open was found to have its interior filled with well-developed young plants. It was satisfactorily determined that these had not originated from intra-ovarian buds, but from seeds, for in some cases the two halves of the testa were still attached to the cotyledons. The pericarp of the melon, though $1\frac{1}{2}$ inches thick allowed a fair amount of light to pass through to the seedlings; and the cotyledons were distinctly green, there being, however, a very small development of chlorophyll. Precocious germination sometimes occurs in the orange and other species of *Citrus*, in the papaw (*Carica Papaya*), in Dipterocarpaceæ, and in Rhizophoraceæ. It is known also in Liliaceæ, as illustrated by an exhibition, at the meeting of the Linnean Society on April 3rd, of some seeds of a *Dracaena*, which had developed into small plants while the berries were still hanging on the parent.

Herr H. Molisch records in the *Berichte der deutschen botanischen Gesellschaft*, 1901, p. 32, his observations on variegation in a variety of cabbage (*Brassica oleracea acephala*). This when cultivated in an unheated house during the winter bore distinctly variegated leaves, but in the summer it was noticed in more than a hundred individuals concerned in the experiment that the variegation completely disappeared, to return in the autumn and winter, reaching its highest development about the end of February. This peculiarity was not affected by the nature of the soil in which the plants were cultivated, but appeared to be wholly due to the changes in temperature. Plants removed from a cold house to a warm one in the winter became green, the process beginning in from eight to fourteen days and being completed in about a month. —S. A. S.

Zoological.—For many years those remarkable West African lemurs known as the potto and the awantibo—both characterised by the abortion of the index finger—were the sole known representatives of their respective genera, the second of the two being extremely rare in collections. In 1879, a potto from the Gaboon was, however, described by a French naturalist as distinct, on account of its larger size, longer head, shorter tail, and greyer tone of coloration. Quite recently, Mr. W. E. de Winton, in a paper contributed to the January number of the *Annals and Magazine of Natural History*, has added a species from the French Congo to each group. The new potto (*Perodicticus batesi*) is intermediate in size between the other two species, and of a richer and more rufous colour than either, the tint being almost that of red mahogany. The Congo awantibo (*Arctocebus aureus*) differs from the typical species of Old Calabar by its inferior size, still shorter tail, in which the terminal hairs are stiff and closely pressed together, and the bright golden colour of the fur, which shows no black tips to the hairs. It may be added that the awantibos differ from the pottos by the structure of the hand, the fuller development of the cheek-teeth, the absence of a projecting ridge of the skull above the aperture of the ear, and of projecting processes to the vertebræ of the neck.

An interesting discovery has been made by Miss D. Bate in certain limestone caves in Cyprus. This consists of remains of a hippopotamus of even smaller size than the one from the Maltese bone-fissures, and only about half the dimensions of the common African species. The describer, Dr. Forsyth Major, regards the Cyprian species as the true *Hippopotamus minutus* of Cuvier, and considers that it displays affinities on the one hand with the living pigmy hippopotamus of West Africa, and on the other with an extinct Italian representative of the group. The occurrence in Cyprus of this dwarf fossil hippopotamus is considered to be confirmatory of the view that many of the later Tertiary mammals of the Mediterranean islands were slightly modified survivors of species which disappeared at an earlier date from the adjacent mainland.

Naturalists have long been familiar with a group of extinct crocodiles from the Kimeridge and Oxford clays of which *Geosaurus*, *Dacosaurus* and *Metriorhynchus* are the best known representatives. It has also been long known that these reptiles lacked the bony scutes in the skin of the back characteristic of ordinary crocodiles, and likewise that the fore-limbs were relatively small and weak, and that the eyes were furnished with a ring of bony plates similar to those of the ichthyosaurs, or fish-lizards. From the associated remains, it was also evident that these crocodiles must have been marine. The structure of the lower portion of the limbs has, however, hitherto been unknown. This gap in our knowledge has been bridged over by the recent discovery in the upper Jurassic strata of the Continent of two nearly complete skeletons of members of the group, one belonging to the genus *Dacosaurus*, and the other to *Geosaurus*. These valuable and interesting specimens have been described by Professor E. Fraas in a recent issue of the German *Palæontographica*, where a restoration of the form of the living animal is attempted. From the structure of the skeleton, it is quite evident that the fore-limbs were short and paddle-like, but the hind pair departed less widely from the ordinary type. The jaws were relatively long and armed with powerful teeth; and it is considered probable that the long tail terminated in a strong vertical fin. The creature must apparently have been a formidable rival to the ichthyosaurs and plesiosaurs of the Jurassic seas.

On a previous occasion reference has been made in these columns to the remarkable lower Eocene vertebrate fauna recently discovered in the Fayum district of Egypt, of which a part has been described by Mr. C. W. Andrews. Mr. H. J. L. Beadnell, in a paper published by the Survey Department at Cairo, gives a note, accompanied by figures, of a remarkable horned ungulate skull, for which the name *Arsinotherium* is proposed. At the conclusion the author states that *Arsinotherium*, so far as can be judged by the character of the teeth, is probably "an ancestral form of rhinoceros." From the figure of the teeth (which is far from satisfactory), we take leave to state that this is precisely what the creature cannot have been.

Every step in the evolutionary history of the man-like apes, and therefore of man himself, has more than ordinary interest for the naturalist. It is accordingly a matter of satisfaction to find that the pedigree has been carried one step further back in time by the discovery in the middle Tertiary of Swabia of teeth of a small ape recently described by Professor Max Schlosser under the name of *Anthropodus brancoi*. This ape is regarded as the probable ancestor of the long-known *Dryopithecus* of the French Miocene.

American naturalists continue to describe species and sub-species of rodents literally by the dozen. For instance, in a paper contributed to the *Proceedings* of the Washington Academy, Dr. Hart Merriam names no less than twenty-three mice of the genus *Rhithrodontomys* as new. Whether these are really entitled to rank as new species or races, it is almost, if not quite, impossible for English naturalists to decide, owing to the fact that no skull-measurements are given. In place of this, the skull is said to be longer or shorter, or wider or narrower, than that of the species with which it is compared, as the case may be. If this omission has been made on purpose, it is scarcely playing the game fairly, as it prevents naturalists other than American from determining new species, or revising those already named.

The raking-up of obscure names to replace those long in use for well-known animals seems carried to an unwarrantable extent by many naturalists of the present day. One of the latest instances is afforded by Dr. J. A. Allen, of New York, who, in the *Bulletin* of the American Museum for February, proposes, on the strength of a passage in Zimmermann's *Zoologicæ Geographicæ* (1777) which may be the result of an error or carelessness, to employ the name *Dama* as the generic title of the American white-tailed deer. By those who regard it as entitled to generic separation from the red deer, the fallow-deer has been invariably designated *Dama vulgaris*, and this usage ought, in our opinion, to bar the use of the former name in any other sense, quite irrespective of whether it was used by some early writer at a date when the binominal system was scarcely established. It is difficult enough in any case to make sportsmen and amateur naturalists realise the essential difference between American and Old World deer, and if a name commonly used for one of the latter be transferred to the former, endless confusion is likely to result. The white-tailed deer is one whose nomenclatural history is singularly unfortunate. The name *Cariacus* by which it was generally known till a few years ago was replaced by *Dorcelaphus* by American writers, who subsequently changed this for *Odocoileus*, and now we have *Dama* suggested.

According to an article in the March number of the *American Naturalist*, a remarkable phenomenon was recently observed on the Californian coast. One day last July a streak of "red water" was noticed some distance off the mouth of San Pedro Harbour, which subsequently broke up into a number of patches, each of several acres in extent. In the course of a few days these patches reached the shore, when the red colour was found to be due to the presence of countless myriads of animalcules belonging to the "flagellate" group. At night the sea was brilliantly phosphorescent over the red area. The most extraordinary fact connected with the visitation was the death of a large number of marine animals, including rays, sharks, and sea-cucumbers, which were apparently poisoned by the animalcules. The bodies of these creatures when cast up on the beach exhaled a most pestiferous odour. At least two hundred miles of coast came under the influence of the "red water."

The Annual Congress of the South Eastern Union of Scientific Societies will be held this year at Canterbury, from the 5th to the 7th of this month. The President-elect, Mr. J. Hutchinson, will deliver the address, and papers will be read by, amongst others, Prof. E. B. Poulton, Prof. G. S. Boulger, Mr. S. Saunders, and Mr. W. Whitaker.

Notices of Books.

"Alcoholism: A Study in Heredity." By G. Archdall Reid. Pp. xvi. + 293. (Fisher Unwin.) Price 6s. net.—Mr. Archdall Reid is a philosopher whose works merit careful consideration. He is outside the circle of what might be termed professional evolutionists, but those of us who have given attention to his writings have found evidence in them of an original thinker possessing both knowledge and inspiration. The line of argument in the present book may be expressed as follows. There is an evolution against disease; the native races of West Africa are able to resist malaria because a process of elimination of those susceptible to the disease has been going on for many generations. Englishmen, however, who have not undergone this process of selection are unable to resist the disease. On the other hand, we have acquired a resisting power against consumption, whereas Polynesians and Eskimo perish as surely in London as Englishmen in West Africa. Again, measles is not often fatal with us, but when the disease is introduced into a new race its ravages are terrible. Alcoholism is a disease, and the races which have been liable to it for the longest period are now the most sober. Accepting this, the conclusion is that the reforms advocated by the Temperance party are fundamentally wrong and can only aggravate the evil. "Including the British, all races which alcohol has afflicted have plainly undergone evolution, protective evolution. They began their experience with a great proneness to drunkenness, have ended with a lesser proneness." Nature would in time eliminate those who are predisposed to drunkenness, whereas temperance reformers aim at preserving them. The method proposed by Mr. Reid is to eliminate the excessive drinker by a Malthusian scheme, which, though biologically sound, is altogether impracticable in the present condition of public opinion. This is a mere sketch of the subjects dealt with, and the whole book is well worth attention by general as well as scientific readers. In one or two places we fancy that the investigations of other evolutionists are referred to in disparaging terms, and we regard this as a mistaken policy. Professor Weldon (not Wheldon as is printed on page 38) is contributing to our knowledge of evolution much more than Mr. Reid, though his methods are different. It is unnecessary to refer slightingly to his work or that of any other earnest investigator in the realm of natural knowledge.

"The Foraminifera: An Introduction to the Study of the Protozoa." By Frederick Chapman, A.L.S., F.R.M.S. (Longmans, Green & Co.) Price 9s. net.—A well written book by an acknowledged authority is always acceptable, and the present volume is the more welcome because it is an attempt to supply a long-felt want. The classical monographs of Carpenter and Brady are beyond the reach of many students, and the innumerable papers on the Foraminifera which regularly appear in the publications of British and Continental scientific societies are for specialists only. Mr. Chapman has endeavoured, and on the whole, we think, successfully, to compress this scattered knowledge into a single volume of some 350 pages. More than half the work is concerned with the classification of the Foraminifera. The leading characteristics of each family are briefly given, and every genus and sub-genus of any importance is illustrated by a description of one or more types. The author is not always happy in the selection of his types, which, in such a text-book, should, we think, have been selected from the commonest and most widely distributed species available, and whenever possible, from recent forms in preference to fossils. Mr. Chapman, however, shows a marked predilection for fossil types, many of them being of restricted disposition even as fossils. Many of the recent species selected as types are also of rare or extremely local distribution, although other species, common or of world-wide distribution, were equally available for the purpose. The figures illustrating the types are somewhat crude, but sufficient for their purpose. The remaining illustrations are excellent, and to a large extent original, a rare occurrence in text-books. The opening chapters are devoted to the life-history and shell structure of the group, and are excellent, but the space allotted to the life-history is altogether inadequate to the subject. The geological history of the group, on the other hand, is treated at some length, and being well illustrated by sections of the more important foraminiferous rocks is of great interest. Mr. Chapman has himself been one of the most untiring workers at the geological record of the group, and in this chapter he records his opinion that the earliest Foraminifera were derived from forms which did not possess an external shell, but consisted merely of sarcode, perhaps covered by a thin chitinous investment. As such bodies could hardly become fossilized, the theory, credible though it seems, can never be definitely proved. The older theory that the earliest Foraminifera were of the arenaceous type has failed to find any support from the geological record, for in the Lower Cambrian strata the group had already obtained a wide distribution and considerable range of structure, all of the *hyaline* type, while the earliest *arenaceous* forams known at present are of Silurian age. The volume concludes with a good selection of the most important modern works on the subject, the assimilation of which should turn the student into a specialist.

"Annual Report of the Smithsonian Institution for the Year ending June 30, 1900." Pp. lxv., 759. Illustrated. (Washington: Government Printing Office.)—One of the many useful services which the Smithsonian Institution renders to students of science is the publication of the Annual Report containing the best and most accurate expositions of scientific subjects selected from various sources by the secretary, Dr. S. P. Langley. The papers which appear in the report are reprints from scientific periodicals or the publications of scientific societies, or translations from French, German and other languages. Each report is thus a survey of scientific thought and progress during the year to which it refers. In the report under notice, much space is given to reviews of the progress of science during the nineteenth century, prepared by men distinguished in their various fields. The subjects reviewed are astronomy, chemistry, geology, physics, electricity, geography, biology, medicine and psychical research, which, with an article on the century's great men of science, give in brief a picture of scientific activity of the last century. China, which figured so much in the public eye during 1900 is given special prominence. There is a brief sketch of the Pekin Observatory, the looting of which caused so much comment, and one on Chinese folk-lore. Aeronautics, which during the last decade has been growing to be considered a science, has several articles devoted to it by Dr. Janssen, Lord Rayleigh, Dr. Langley, and others. Among the thirty or more other articles may be mentioned, as illustrating the variety of the subjects treated, papers on malaria and the transmission of yellow fever, by Surgeon-General Sternberg, an essay on Huxley, by Professor Brooks, and a paper on incandescent mantles. The Smithsonian Reports are distributed to institutions throughout the world, and may be had by purchase at cost price from the Superintendent of Documents, Washington City, U.S.A. Their value can only be adequately appreciated by becoming familiar with them, and we recommend all who are able to see them to take an early opportunity of doing so.

"More Tales of the Birds." By W. Warde Fowler. (London: Macmillan & Co. 1902.)—Mr. Warde Fowler has again succeeded in producing a most charming book for juvenile readers, and one which cannot fail to instil a love of the country and a fondness for birds. The author combines the rare qualities of a skilled ornithologist and a story-teller of singular fascination; as a result, the several chapters of his book all faithfully reflect the characteristics of the various birds which he has selected. Only in one case have we come across a jarring note. He goes out of his way, it seems to us, to sow an early prejudice against one of the most ruthlessly persecuted of birds —the heron. Inasmuch as he depicts this poor bird as making a meal of the most sacred person of a trout! It is this occasional piece of audacity on the part of this poor bird that has brought about his undoing wherever trout streams abound, for the proprietors thereof will brook no fishermen but themselves. Thus, the budding naturalist, who may later in life become an enthusiastic angler, is started on his career of persecution of one of our most interesting and fast vanishing birds. Why would not an eel, or a water-rat, have served as well as a trout? They form a far commoner proportion, moreover, of the food of the heron than the fish he selects. The illustrations suggest the hand of a novice, but the pictures of the kite and the sandpipers give promise of very considerable skill in the future, the kite being especially good.

"Results of Rain, River, and Evaporation Observations made in New South Wales during 1899." By H. C. Russell, B.A., C.M.G., F.R.S., Government Astronomer, New South Wales. (Sydney: William Applegate Gullick.) 1901. Price 3s. 6d. With Maps and Diagrams.—This volume deals with the romance of the raindrops, and although the story is told in statistical form it is full of interest. That the tables of figures which detail the observations made at 1724 stations have been aranged under the supervision of Mr. Russell is a guarantee that they will be found lucid and to indicate clearly the precise nature of the facts dealt with. The publication is mainly concerned with the general results of rainfall observations during 1899, but there are in abundance additional tables that show the rainfall records in Australia at a number of stations during the sixty years 1840 to 1899. These statistics indicate the amount of rain that fell during certain months and years in different parts of the colony, the averages being also given for the purposes of comparison; but in order to complete the full history of the raindrops other particulars are required, and these this volume provides. Thus when once the rain has fallen on the ground it is necessary to learn something of the way in which it disappears. Some of the water, for instance, evaporates almost as soon as it falls; while a certain amount percolates underground. Much of the water, again, may rush over the surface of the ground into the rivulets, streams, and rivers and so produce floods. To engineers and others, therefore, who are concerned with reservoirs, springs, and wells, not only is it important to be told the depth of rain that fell, but on the other side of the account something should be said concerning evaporation, percolation, and floods. As regards the latter, Mr. Russell gives the height of certain rivers from day to day, the figures being obtained by means of river-gauges and flood-marks placed on bridges. There are no percolation observations in this book, but since there are so many other interesting tables and diagrams no one would find fault with the omission, although a few such details would have added to the value of the volume. The statistical part of the observations is illuminated by seven diagrams at the end of the book, and reference may be made to one of them which shows the monthly distribution of the rainfall in different districts, and reveals the character of the year's rainfall in a most excellent manner. Another diagram has reference to the debatable question of the moon and the weather, Mr. Russell is "convinced that there is some connection between the two." Meteorologists as a body are, however, not yet persuaded that any hints as to future weather are to be gained by looking in this direction, and those who are engaged in preparing what may be termed the official forecasts prefer, at present, to consult a synchronous chart rather than the moon. In order that the mean annual rainfall over New South Wales as a whole, which is 25 inches, may be compared with other parts of the world, Mr. Russell has compiled a table giving the averages for thirty-three representative localities. At the head of this table stand the Khasia Hills, India, with a mean annual rainfall of 600 inches, Madrid with 9 inches is at the bottom; London has 24 inches, and New York 47 inches. But no attempt must be made here to extract the statistical "plums" from this well-compiled volume, to which anyone interested in rainfall matters may safely be commended.

"The Nearer East." By D. G. Hogarth, M.A. With Maps and Diagrams. Pp. xv., 296. (Heinemann.)—This volume is the second of the series edited by Mr. H. J. Mackinder, having for its object the description of the great regions of the world in relation to the people inhabiting them. Geography as it is now understood is concerned with the influence of environment upon human life; it is an endeavour to determine the conditions which have led to the adjustment of things as they are. The most important factor is the relief of the earth's surface, which determines to a large extent the climatic conditions, and through this the character of a race, causing, for instance, the peasant of the Nile Delta and the fellah of the Upper River to be very different beings. The density of the population is largely dependent upon the nature of the country. Thus, while Egypt with desert areas included has a population averaging about 12 to the square mile, the number on the land without deserts amounts to 600 per square mile. By several remarkable examples, Mr. Hogarth shows how the character of man is affected by the nature of the available food supply. "Over the immense area of south-western Asia, where grain can be cultivated so little as to be in no sense a staple food, and the date fruit, heating and satisfying, but not of equal nutrition, takes its place, we find one character of man, restless and alert, but incapable of sustained action or any but the most superficial and conventional thought." There is, in fact, a regular gradation in an upward scale of physical endurance and intelligence from the lowest date-eating Bedawin to inhabitants of the Lebanon and the Syrian coast, where wheat and olive, milk and wine, are among the staples of life. We cannot refer to the many other interesting facts of a similar nature described by Mr. Hogarth. About one-half of his volume deals with the physical geography of the "Nearer East," which includes the tracts of lands which lie in and about the eastern basin of the Mediterranean Sea. The second half is concerned with the distribution, character and conditions of human life in this region. The book shows how geography can be studied in a perfectly scientific manner, and will thus do something to remove the re-impression that the subject has no place among the sciences. The author has overlooked the loose expression "different to" on page 17.

"A Concise Dictionary of Egyptian Archæology." By M. Brodrick and A. Anderson Morton. Pp. viii. and 198. (Methuen.) Illustrated. 3s. 6d.—Students and travellers may find this little handbook of service, but they must of course recognise that it only contains a limited statement of the position of Egyptology. A few points worth remark occur to us in glancing through the pages of the book. A list of the principal gods might have been given; at present the word "god" is not indexed. We also miss the words "metals" and "chronology," though both deserve a paragraph. Under "zodiac" it is stated that the zodiacs found in Egypt "were borrowed from the Greeks," whereas the reverse was probably the case. Under "temples" no mention is made of the care taken in their foundation to keep the axis in a definite direction, or of their use for observations of the rising or setting of the sun and stars; and no reference is made to the remarkable fact that the bases of the Great Pyramids lie in the four cardinal points. Sirius is said to be in the constellation Canis, instead of Canis Major. Concerning the source of the Nile it is remarked "modern travellers place it in the Victoria Nyanza Lake, but it is quite possible that it rises even further south of the Equator." Whether the Kagera, the Shimeya, or the Mwaru is the head stream of the Nile may be doubtful, but no one now considers the Victoria Nyanza to be the source. Putting aside minor mistakes of this character, the book will be handy as a guide, though it cannot be taken as authoritative.

"An Introduction to the Study of the Comparative Anatomy of Animals." Vol. II. By Gilbert C. Bourne, M.A., D.Sc., F.L.S. (London: George Bell & Sons. 1902.)—As in his previous volume, Dr. Bourne has contrived to crowd into a small space a vast amount of information specially designed for students reading for the preliminary and intermediate science examinations in the Universities of Great Britain. But so well has the work been planned, and so carefully and discreetly have his facts been selected that we venture to predict his two volumes will be treasured long after they have served the purposes for which they are written. The present volume deals with the platyhelmia, annelida, mollusca, gastropoda, arthropoda, cephalochorda, elasmobranch fishes and mammalia, and contains a chapter on the development of the frog. According to the plan of the work only the essential features of the various groups are discussed, and room is even found, here and there, for philosophical speculation which must certainly greatly add to the value of the work.

We have received several volumes of the Unit Library. The main feature of this latest addition to the growing family of miniature booklets is that they are to be sold at prices based on the number of pages, irrespective of internal worth. The covers and general appearance are pleasantly decorative and the type clear.

BOOKS RECEIVED.

The Criterion of Scientific Truth. By George Shann. (Cassell.)

Arithmetic and Algebra. By John Davidson, M.A. Edited by John Adams, M.A., B.Sc. (Hodder & Stoughton.) 2s. 6d.

Dynamic Aspects of Nutrition and Heredity. By Frank Horridge. (Baillière, Tindall & Cox.) 5s. net.

The Conflict of Truth. By F. Hugh Capron. (Hodder and Stoughton.) 10s. 6d.

Other Worlds. By Garrett P. Serviss. (Hirschfeld.) 6s. net.

Complete Works of Miguel de Cervantes Saavedra. Vol. VIII. (Gowans & Gray.) 1s. net.

Elementary Plant Physiology. By D. T. MacDougal. (Longmans.) 3s.

Remarkable Comets. By W. T. Lynn. (Sampson Low.) 6d.

Mosaic Account of Creation Verified by Science. By George Dickison. (Stock.)

Results of Meteorological and Magnetical Observations. (Stonyhurst College Observatory.)

Religions of Bible Lands. By D. S. Margoliouth, M.A. (Hodder & Stoughton.) 1s. net.

Will Power. By Richard J. Ebbard. (Modern Medical Pub. Co.)

Nature Note Book. By W. L. Boys-Smith. (Allman & Son.)

The New Phytologist. Vol. I., No. 4. 1s. 6d.

The Lens. By Thos. Bolas, F.C.S., F.I.C., and George E. Brown, F.I.C. (Dawbarn & Ward.) 2s 6d. net.

Edward Edwards. By Thomas Greenwood. (Scott, Greenwood & Co.) 2s. 6d. net.

Journal of the Anthropological Institute. Vol. 31, 1901. 10s. net.

Regeneration. By Thomas Hunt Morgan, PH.D. (Macmillan.) Illustrated. 12s. 6d. net.

Occultations of Stars and Solar Eclipses. By Francis Cranmer Penrose, M.A., F.R.S., &c. (Macmillan.) Illustrated. 12s. net.

Experiments with Ionized Air. By Carl Barus. (Smithsonian Institution.)

Report of S. P. Langley, Secretary of the Smithsonian Institution for the Year ending June 30th, 1901.

Conférence Astrophotographique Internationale, July, 1900. (Paris: Gauthier-Villars.)

Manual of Tides. Part IV.A. Outlines of Tidal Theory. By Rollin A. Harris. (Washington: Government Printing Office.)

Magnetism in Growth. By Silvanus P. Thompson, B.A., D.Sc., F.R.S. (Frowde.) 1s. net.

Small Dynamos and Motors. By F. E. Powell. (Dawbarn & Ward.) 6d. net.

Lord Kelvin, G.C.V.O. By John Munro. (Bijou Biographies, No IX.) (Drane.) 1s.

Notes on the Construction of the Violin. By W. B. Coventry, M.INST.C.E. (Dulau.) 2s. 6d. net.

Story of Animal Life. By B. Lindsay. (Newnes.) Illustrated. 1s.

Summer Birds of Flathead Lake. By P. M. Silloway. (University of Montana.) Illustrated.

Journal and Transactions of the Leeds Astronomical Society (1901). (Wesley & Son.) 2s.

Hints to Meteorological Observers. By W. Marriott, F.R.MET.SOC. Fifth Edition. (Royal Meteorological Society.) Illustrated. 1s. 6d.

Rhodes' Steamship Guide. Edited by Thomas Rhodes. (Philip.) 2s.

Essays Civil and Moral. By Francis Bacon. (Ward, Lock.) 2s.

Essays in Historical Chemistry. By T. E. Thorpe, C.B., LL.D., F.R.S. (Macmillan.) 12s. net.

Principles of Inorganic Chemistry. By Wilhelm Ostwald. (Macmillan.) 18s. net.

Country Gentlemen's Estate Book, 1902. Coronation Edition. (Country Gentlemen's Association, Limited.) Illustrated. 3s. 6d. net.

Butterflies and Moths of Europe. By W. F. Kirby, F.L.S., F.E.S. (Cassell.) 7d. net.

Photographic Catalogue. Jas. Woolley, Sons & Co., Limited.

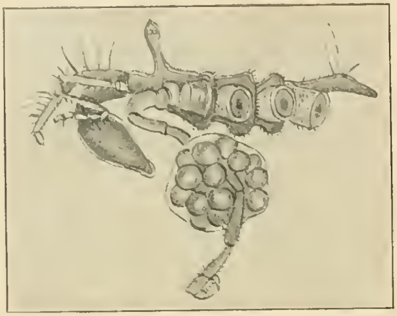
THE NOBODIES,—A SEA-FARING FAMILY.

By Rev. T. R. R. Stebbing, M.A., F.R.S., F.L.S.

CHAPTER III.

In the upper classes of the animal kingdom, among creatures that display bilateral symmetry, the head is always set on in front. When Herodotus heard from the Libyans of a headless tribe with eyes in their breasts, he characterized this and some other marvels as a pack of lies. A sermon attributed to St. Augustine makes the eloquent Numidian bishop claim to have actually seen the tribe of which Herodotus had only incredulously heard, but the sermon has been denounced as a shameless forgery. Stories there are of men who carry their heads under their arms. Anyone can do that who appropriates his neighbour's head for the purpose. Such an exception is purely artificial. Even the Pycnogonida have their heads in the ordinary position, though for reasons best known to themselves here again they are not content to do the usual thing in the usual fashion. A dispassionate observer, unbiased by inquisitive researches, would readily, one might almost say reasonably, conclude that for this group the head is constituted by the prominent, generally large, often very freely movable, front portion of the animal which contains the mouth. Head and mouth are in fact among the names which have been applied to this part. It has also been designated by words signifying rostrum, siphon, proboscis. Of the five, the last has been the favourite term. It must not, however, be taken to imply a nasal prolongation, as in the elephant and the tapir; nor is it composed of modified jaws as in insects. This was an early view of it, which recent authorities strenuously reject. It is tubular, with a cylindrical or fusiform appearance emerging from a three-sided structure, in which an upper plate forms the roof, the other two constituents meeting in a more or less keel-like manner below. The opening and shutting of the mouth at the anterior end is managed by three little valve-like plates, or some equivalent arrangement. The internal mechanism is described by E. B. Wilson as an apparatus for masticating food, by Meinert as a filtering apparatus, by Dohrn as a creel-like trap contrived, like those in which crabs and lobsters are caught, to let things in and not to let them out again.

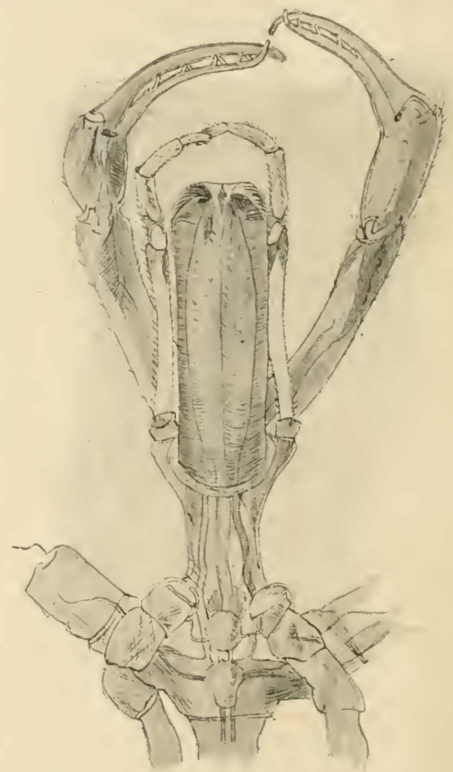
It is generally agreed that, in animals which take food, whatever else may be or not be the appurtenances of a head, it always includes the mouth. A head without a mouth is worse off than a duke without a duchy. So far then the proboscis above described by having a mouth makes a capital claim to be the head, and when it happens to be fusiform, its neck-like attachment to the rest of the body gives it a semblance of being not merely a part of the head but the whole. Many animals, crustaceans and spiders for example, dispense with a neck, having the head fused with the trunk. But it is not easy to think of an animal which has a neck in the middle of its head, enabling it to double one half under the other. This singular aerobatic performance is, however, accomplished in the



Eurycyde hispida (Kröyer); ambulatory legs omitted. From Sars.

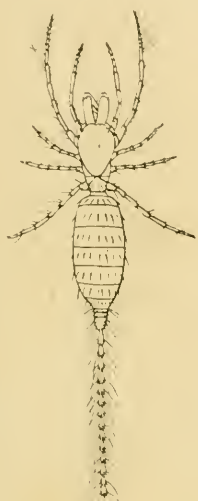
present group, as for instance by *Eurycyde hispida* (Kröyer); but it needs some explanation. For arthropods in general, and for vertebrates it must be admitted that, besides the feeding aperture, two other constituents of supreme importance, the eye and the brain, are always localized in the head. The eyes and brain do not wander away from the head of an arthropod, unless they wander away from the animal altogether. Yet look now at these perverse Pycnogonida. Behind the proboscis, which is sometimes relatively huge, there is a body consisting of four segments, followed by a little trivial abdomen, articulated or in coalescence, depressed, outstanding, or more frequently upturned. The four segments of the trunk are often very distinctly separated one from the other, but in some species they are more or less fused together, although the original independence of the last three is always sufficiently guaranteed by the pair of legs which each has in attachment to its sides. The first segment also has a similar pair of legs in similar lateral attachment, but it has much more. It is capable of bearing three other pairs of appendages, and sometimes, though not always, exercises this capacity. The nervous mass that does duty for a brain is lodged within it. On its outside rises an eminence, a little watch-tower, normally beset with four simple eyes, two of which look backward and two forward. That this first segment, then, to judge by the four pairs of appendages, is in reality composite, few zoologists will be inclined to dispute. That part of it is cephalic or in the nature of a head-piece, since eyes and brain are lodged in it, most will readily admit. But this admission carries with it the inference that the proboscis, notwithstanding its possession of the buccal orifice, is not properly or exclusively the head. It may rather be regarded as the throat and mouth projected strongly forward so as to assume an abnormal prominence. It is in keeping with the eccentric character of these creatures, the "nobodies" of our title, that they should thus threaten immense gulosity in spite of those circumstances which convict them of hermit-like abstemiousness.

The three pairs of appendages that precede the walking legs on the composite first segment appeal for distinctive names, and still remain in the distressful condition of not knowing with any sort of certainty what to call themselves. Of the first pair it may be said that they are normally three-jointed and chelate. They frequently extend beyond the proboscis in a way that would seem convenient for offering meat to its mouth. But they display many vagaries. Very occasionally they are four-jointed, sometimes they are two-jointed or one-jointed, or no-jointed, disappearing altogether. Under some of these conditions they cease to be chelate, not being able to form pincers with fewer joints than two, or not choosing to do it with that number or more. At times they remain chelate,



Nymphon perlucidum, Hoek. Front of body from below. From Hoek.

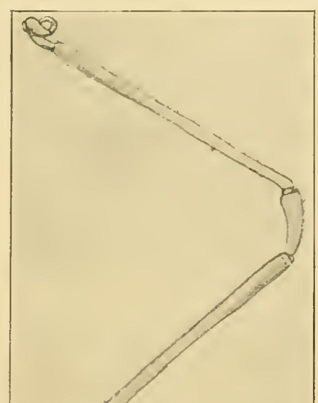
though not reaching so far as the mouth-opening. It must be tantalizing to the mouth if they persist in offering food from an unattainable distance. But perhaps they adopt the policy of the long spoon, presenting a desirable morsel on the end of a stalk. In contrast with the inconstancy and variability of these appendages in the adult, they are found to be in the larva, so far as is known, always present, always three-jointed, always chelate. By that fact may be justified the convenient designation "chelifori," which has been applied to them, since in all species they are at least for some part of the animal's life carriers of chelæ. Still such a title is merely neutral. It is secure from criticism because it leaves out of sight considerations of homology. It is unhelpful to those who would fain know the relation of these chelifori to corresponding appendages in other arthropods. In this respect there is an embarrassing choice of opinion, for some think them equivalent to the first pair of antennæ and some to the second, some to the mandibles, and some to a pair of maxillipeds. It is, perhaps, worth while going a little out of our way to illustrate the perplexing obscurity of the problem. A remarkable arachnid, *Kœnenia mirabilis*, first described by the Italian authors Grassi and Calandruccio, was afterwards more exactly studied by the Danish savants H. J. Hansen and W. Sörensen. Recently Dr. Meinert, while



Kœnenia mirabilis, G. and C. After Hansen.

referring with high praise to the description and figures supplied by his colleagues at Copenhagen, deduces from them a conclusion which they themselves do not accept. He finds in *Kœnenia* a proboscis homologous with that of the Pycnogonida. Projecting in front of its mouth are seen a pair of "antennæ," three-jointed, chelate, which not a little resemble the pycnogonid first appendages. There is a further point of comparison. In the scorpions, pseudoscorpions, and many of the Pedipalpi, the "chelicerae" are followed by long chelate organs forming the second pair of appendages. In the Pycnogonida the second pair, though as variable as the first, are never chelate, and in this respect they again agree with *Kœnenia* as well as with some of the Pedipalpi. But *Kœnenia*, it will be seen, has only six pairs of appendages, not the mystic pycnogonid seven. Among all the peculiarities of the latter group it would surely not be the least, if *Kœnenia* with the abdomen abnormally developed could be proved to be the nearest living relative of a tribe which has the abdomen abnormally insignificant. Such a conclusion is at present highly improbable.

The second appendages, or "palps" as they have been most commonly called, have a number of joints varying from ten to five, and are liable to vanish entirely. When present they have their place of attachment generally close to the chelifori, and a neck-like constriction of the supporting segment often puts them far apart from the ovigerous legs. Yet, when the segment is very short, they are sometimes brought into close contiguity with these, which in their turn lie close to, or rarely at a little distance apart from, the first pair of walking-legs. The ovigerous function has been already discussed. The third appendages to which it belongs have other claims to attention. In the first place, however convenient they may be to their possessors, they are very trying to the systematist. They helped Savigny to a comparison of the Pycnogonida with a crustacean type, but it was fanciful and untenable. When the comparison is transferred to all existing Arachnida, *Kœnenia mirabilis* included, this third pair of appendages appears to be a pair too many. Semper overcomes this difficulty by regarding them as a new formation, and Meinert thinks this a fair solution, in opposition to Dohrn, who regards it as an explanation which merely confesses inability to explain. In regard to the Entomostraca a theory was long maintained by the late distinguished professor, Carl Claus, that the two branches of a crustacean limb could separate and form two apparently distinct appendages. He sometimes complained that this discovery was ignored or not sufficiently appreciated by the scientific world. One sees how exceedingly convenient it would be in the present difficulty if one might suppose that the second appendages in the Pycnogonida were mere offsets either of the first pair or the third. There are obstacles in the way of this solution. The bifid structure, so common in crustacean appendages, has



Ovigerous leg of *Colossendeis gigas*, Hoek. Natural size. From Hoek.

no prominence in those of the Arachnida or Pycnogonida. But the position of affairs would not be much improved if it had, for it so happened that, just as the world was coming to accept the late professor's theory, solid objections were raised to it by other naturalists and eventually it was abandoned by its author. The origin, then, of this third pair of appendages remains mysterious. The minutiæ of their structure, without making much appeal to the unaided eye, show some striking and beautiful characters under the microscope. The weak-looking joints at the end of the limb are usually bordered with rows of spines, of which the varied sculpture would scarcely be suspected until it has been seen under a high magnification. The numbers and shapes of these leaf-like and sometimes strongly denticulate spines are helpful in generic distinction. The number of them may be quite trivial or it may amount as in *Colossendeis gigas*, Hoek, to several hundreds. The worn condition of the apparatus in the specimen figured implies a period of active service, and considering that the species in question is capable of growing legs twelve inches long, it may well be that the cleansing appendages find themselves severely taxed in brushing up and keeping trim all the four pairs.

Unlike the organs already discussed, the ambulatory limbs, with only one known exception, have always the same number of joints, which is nine. *Gnamptorhynchus ramipes*, Böhm, is without the terminal joint in the first pair. Of the nine joints, the middle three are almost invariably the longest. In other respects there is abundance of variation, distinguishing legs that are stumpy from legs that are of a marvellous attenuation, legs that are spiny from legs that are smooth, and especially legs that have the ninth joint or claw accompanied by a couple of auxiliary claws from legs that have no such accessories. Dr. Meinert says, "These auxiliary claws are really the terminal claws of the foot, originating from and attached to the last joint (the claw) of the foot. In so far they are real

Spines on ninth joint of ovigerous leg; *Colossendeis gigas*, Hoek. Highly magnified. From Hoek.

claws, and correspond to the claws in the Arachnida and most Insects. Corresponding claws are wanting in the Crustacea, and therefore their presence in the Pycnogonida is of no small systematic importance; it is to be remarked, however, that they often become rudimentary or quite disappear, but, nevertheless, they may be said to be typical in this group of animals." As qualifying this view it should be borne in mind that supplementary claws are not unknown among Crustacea, at least as occurring on the inner side of the principal unguis, while on its outer side the Amphipoda quite usually have a seta at the very point at which in pycnogonids the auxiliary spines originate. But between setae and spines nature has left no interval unbridged.

To complete the account of the appendages, the patient reader must allow his thoughts to be transferred to the time when the young pycnogonid is just escaping from the egg and still trusting to the benevolent support of its father's arms. Between the emerging larva, more compact than graceful, and the parent, usually with long, slim, radiating limbs, there is almost no resemblance. In the earliest stage, which may exceptionally be passed within the egg-cover, the little creature has no abdomen, but a swollen trunk and three pairs of appendages, this latter characteristic suggesting a comparison with the crustacean nauplius. But here the first pair are chelate, and the

Larva of *Pycnogonum littorale*, Brünnich. After Kröyer.

two following pairs are simple, not two-branched as in the nauplius, so that the difference is very substantial. With the progress of development the four pairs of walking-legs successively appear. But in the meantime, according to Meinert, the second and third larval appendages are thrown off, and then the "palps" and "ovigerous legs" come on to the scene, Meinert's theory being that these are not representatives of the two discarded larval pairs, but of quite independent origin. Hence he affirms that the typical number of pairs of limbs in the Pycnogonida is not seven but nine. Of these nine, he holds that the last four pairs "are not at all homologous with the ambulatory legs of the Arachnida, but in all likelihood with the four pairs of small processes that have been pointed out in the abdomen of the Arachnid-embryo." Taken altogether, the arguments he uses to justify his classing this group among the Arachnida may rather incline observers to leave him in this respect ploughing a lonely furrow. In 1891, Prof. G. O. Sars expressed the belief "that all naturalists are at present unanimous that those animals [the Pycnogonida] can neither be referred to the Crustaceans nor the Arachnidans, but must form a class by themselves."

Future researches may at any time remove the group from its splendid isolation. For the present, in regard to external relationships, we shall do well to leave it alone in its glory. Within its own confines there remains to be considered the relative importance of agreements and differences on which the distinctions of its species, genera, and families have been founded.

Conducted by M. I. Cross.

POND-LIFE COLLECTING IN JUNE.—The months of April and May have been so abnormally cold this year that it is to be expected many of the pond organisms which usually make their appearance in May will have been retarded, and will only come on in June. There are, however, summer forms which hardly ever occur earlier than June, and the most interesting of these amongst Rotifers is *Pedalion mirum*, with its six arthropodous limbs; *Synchæta stylata*, with its long-spined floating eggs, and *Synchæta grandis*, the largest species of this genus, may also now be looked for in lakes and water reservoirs, as well as the rare free-swimming *Floscularia pelagica*. In the same waters will be found two free-swimming colonies of Vorticella: *Epistylis rotans* and *Zoothamnium limneticum*. In June it often happens that certain water-fleas, Daphnia and Bosmina, also Cyclops and their larvæ, increase to such an extent as to render the existence of free-swimming Rotifers almost impossible in these waters, and the latter consequently quickly disappear, though they may have been swarming a few weeks earlier. In ponds, however, where this does not occur, Rotifers of many genera may be found, and attached to submerged water plants *Lacinularia socialis* and *Megalotrocha albo-flavicans* should be looked for, whilst in reedy ponds the free-swimming spheres of *Conochilus volvox* may occur. Mossy pools, in addition to their special rotiferous fauna of *Philodinæ*, *Callidinæ*, *Adineta*, *Cathypnæ*, *Distyla*, and *Monostyla*, will also contain waterbears and shelled Rhizopods such as *Difflugia* and *Arcella* and numerous free-swimming Infusoria. Polyzoa, such as *Plumatella repens*, *Fredericella sultana*, *Lophopus crystallinus*, and *Cristatella mucedo*, though not common, should be abundant in suitable localities.

COVER-GLASS CORRECTION.—With dry microscope objectives of considerable numerical aperture, the thickness of the cover-glass through which an object is examined is found to seriously affect the definition of the image: an objective which is quite satisfactory with some definite thickness of cover-glass showing decided spherical aberration in the sense of under-correction when the cover-glass is thinner, in the sense of over-correction when the cover-glass is thicker, than the standard adopted by the optician. This spherical aberration results from the refraction of the rays in the plane surfaces of cover-glass and objective-front respectively, and is negative for the cover-glass surface, positive in the front lens-plano, the latter preponderating owing to the greater diameter of the cone of rays from the object where it enters the front lens.

With the right thickness of cover-glass, the remaining under-correction is exactly balanced by an equal over-correction in the lenses of the objective; but a *thin* cover-glass produces insufficient over-correction (the diameter of the cone of rays being too small where it meets the surface of the cover-glass); a thick one too much.

As it is not practicable to strictly adhere to the standard thickness of cover-glass adopted by the makers of an objective, it becomes necessary, at least in critical work, to compensate for the effect of the cover-glass, and this can generally be done in two ways, viz.:—

1. The tube length is found to affect the spherical correction, lengthening of the tube introducing over-correction, shortening of the tube under-correction. Hence, we may generally secure good definition with objectives in fixed mounts, even when the thickness of the cover-glass differs considerably from the standard, by adjusting the tube length, thick covers requiring a shorter, thin ones a longer, tube. It may, however, be mentioned that some of the relatively cheap "achromatic" or "semi-apochromatic" objectives by leading Continental makers form a curious exception; they give very good definition with their standard cover-glass, but no alteration of tube length seems to enable one to get anything like the same definition with cover-glasses of considerably different thickness.

2. With objectives of short focus the range of tube length is hardly sufficient for the purpose of compensation; for these the adjustable mount—"correction-collar"—is a very desirable and useful arrangement, which acts by altering the distance between the front and back lenses of an objective. A reduction of this distance introduces under-correction; an increase, over-correction, and a scale on the "collar" serves to indicate the position of the lenses.

Most English opticians seem to adhere to the old plan—very convenient and inexpensive to them, but puzzling to the microscopist—of an arbitrary scale; the German plan of carefully marking the scale so as to show the thickness of the cover-glass in 1/100ths of a millimetre seems ever so much more convenient and useful.

With an objective having a scale thus divided and an object under a cover-glass of known thickness, the use of the collar is simplicity itself; we simply set the collar to the division of the scale corresponding to the thickness of the cover-glass, and the tube length to that stated by the maker, and the instrument will at once give its best definition.

But generally these ideal conditions do not exist, and then the adjustment of the tube length, or of the correction-collar, becomes a delicate and difficult operation, which may, however, be accomplished in a systematic manner, if we bear in mind that we are aiming at the elimination of "spherical aberration." The latter may be defined as a difference of focus between the central and marginal zones of an objective. Hence the correct tube length or the correct position of the correction-collar has been found when some strongly-marked detail or outline of the object remains in exact focus under any change of illumination, say from a small to a large diaphragm opening, or, better still, from central to very oblique light, these changes being of course made very carefully so as not to disturb the other adjustments.

The following *modus operandi* will be the safest and quickest. Start with the shortest tube length, or when there is a correction-collar with the position corresponding to the thickest cover-glass, carefully focus some sharp outline with, say, a ¼ central cone; then change to a ¾ cone, or, still better, to very oblique light. Unless the object—owing to an exceptionally thick cover-glass or a very badly-adjusted lens—is beyond the range of your adjustments, you will find evidence of under-correction, that is, the lens will have to be brought closer to the object with the wide cone, or oblique light, than with central light.

Gradually lengthen the tube, or turn the collar, repeating the above observation after each changing until all evidence of spherical aberration has disappeared; the instrument is then in correct adjustment *within your own limits of vision*.

It is advisable to start with the adjustment corresponding to the thickest cover for the simple reason that this lessens the danger of running through the cover-glass and destroying the object and possibly the front lens of the objective when dealing with a lens of a short working distance.

PRACTICAL SCHEME.—A reader—Mr. J. Searle, of Oporto—has kindly sent a considerable number of centipedes of an unusual kind, which I have so far been unable to get identified, for distribution among readers of KNOWLEDGE. Unfortunately they have been sent in a dry condition, and very few of them are, in consequence, whole, but, with care, very interesting slides can be prepared of the various parts, and especially the legs, which appear to be the most interesting feature.

I am hoping, within the next few weeks, to receive a further quantity from this gentleman, preserved in spirits of wine, and shall be pleased to send a specimen to a limited number of readers who apply for same, enclosing a stamped addressed envelope.

The method of treatment for these insects would be as follows:—Place them in water for three hours, transfer to ten per cent. of caustic-potash in distilled water until they become soft; this will probably take some days. When soft, pour away the potash and add water, which must be changed several times until all the potash is washed away. Pour away the water and add concentrated acetic acid and soak for twelve hours, or until a convenient time for continuing the process, when they should be transferred from acetic acid to water and soaked for half an hour. Lay out in the manner desired, and after once more hardening in spirits of wine, and clearing in clove oil, they should be placed in turpentine and mounted in Canada balsam.

Full particulars of the above processes will be found in the many works that give instructions in mounting.

Advice in Preparing Specimens.—At this time of year many microscopists will be collecting specimens which will prove interesting under the microscope, and would, no doubt, in many cases, wish to permanently preserve them. I shall be pleased at all times to give any advice or assistance I can to aid in such work.

NOTES AND QUERIES.

R. W. S.—Desmids should grow well in a shallow cell in some of the water in which they were found; tap water will not do. I am unaware of the existence of the article in the journal you mention.

T. H. A.—The specimen you send is not sufficiently perfectly mounted for identification, but it looks uncommonly like the Spinning Mite of the lime tree, *Tetranychus telarius.*

Ignoramus.—Good portable microscopes, as well as instruments suitable for the purpose of an amateur, are supplied by all the makers whose advertisements appear in these columns. For examining flowers, etc., Mr. C. Baker, of 244, High Holborn, makes an especially convenient little instrument called the "Plantation" microscope, which would probably do all you require. Good second-hand microscopes can be obtained from several houses, and particularly Messrs. Clarkson & Co., of Bartlett's Buildings, E.C. The book that you would probably find most serviceable is "A Popular Handbook to the Microscope," by Lewis Wright, price 2s. 6d.

C. M.—I have referred your letter to the gentleman who has kindly consented to act as consultant with regard to Rotifera, and he replies as follows:—"I am afraid that the smaller Entomostraca are, like the poor, always with us. When collecting myself, I pass all the water through a small strainer (sold in the streets for a penny), and I find that this keeps out all the larger forms such as Daphnia, etc. I must admit I do not find many free-swimming Rotifers as large as Daphnia or Cyclops, unless the latter are very small, but I think your correspondent would find it possible to make a muslin strainer coarse enough to let through most of the Rotifers, and at the same time keep out all the large Entomostraca. But to get rid of Cypris and Chedorus I am afraid will require a pipette and infinite patience."

Correspondence is invited on the subject matters dealt with in these columns. Readers may see subjects from different points of view and their criticism will be welcomed.

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.

New Comet (1902 A).—A new comet was discovered by Mr. W. R. Brooks, of Geneva, U.S.A., on the morning of April 15th, when it was in about 344° + 29°, and two degrees north of β Pegasi. The comet was travelling rather quickly to the south-east, and it was observed on April 17th by Prof. E. Hartwig, at Bamberg, who described it as of $8\frac{1}{2}$ magnitude, about three minutes of arc in diameter, and with a tail neary half a degree long. The object approached the sun so rapidly that it was only observed for a short period, and it arrived at perihelion on May 7th, when in a position about 25 degrees south of that luminary. Thereafter the motion was directed towards north-east, but it soon slackened and prevented the comet from emerging from the sun's rays to become visible in the evening sky. The object receded rapidly from the earth, and its apparent brightness declined to such a degree that it is questionable whether it was seen at all after its perihelion passage, except from stations in considerable south latitude. The comet's apparition may be regarded as a very fugitive one, and the conditions appear somewhat similar to those which affected the great southern comet of last spring, and confined its visibility to narrow limits

Great Detonating Fireball seen in Sunshine.—On the morning of April 10th, at about 10h. 55m. G.M.T., when the sun was shining brightly, a large fireball was seen in the northern sky from Dunsink, Co. Dublin, and Carlow, and at about the same time a strange sound was heard over East Tyrone by many people, who were startled at its unusual character, and considered it either the presage or accompaniment of an earthquake. A large number of descriptions of the phenomenon have been published in the *Irish Times*, and a few accounts have been privately communicated. From these the following are selected:—

Mrs. Martin, of Dunsink, says: "While walking down the fields my atention was attracted by a rushing noise above my head, and glancing up I saw a beautiful pear-shaped object, with a tail about six times as long as the head, going in a northerly direction. The head was of dazzling brightness, having the appearance of the electric light, and changing to a golden shade before it vanished. As I watched the object the tail suddenly broke in two, leaving the pear-shaped head and part of the tail separate; then the broken tail seemed to rush into the head, and drop out of sight. Before I saw the object, and all the time I was watching it, which could only have been for three or four seconds, I distinctly heard a rushing sound I first saw the meteor when directly over my head, and it disappeared at an angle of 10° from the N. horizon."

Herr Boeddicker, of Lord Rosse's observatory, Birr, writes to the *Irish Times* of April 27th as follows:—"My attention has been drawn to numerous letters concerning a rumbling sound heard over East Tyrone, and ascribed by various writers either to a meteor or an earthquake. That the former explanation is the true one is established beyond a doubt by the fact that Master R. FitzMaurice, of Carlow, saw the meteor at the same time, viz., 10h. 30m. (Dublin time). It flashed into sight in the N.E. in full sunlight, and left a long train behind."

With regard to the strange sound, the Rev. E. F. Campbell, of Moy, says it occurred at 10h. 30m. (Dublin time), and that he was standing talking to his gardener at the time. The morning was perfectly still, the sun shining, and mist rising. "The sound seemed to be very deep in the heavens; to the east it appeared to be far above thunder distance, and about half as loud. It lasted from 30 to 60 seconds, and I can only describe it as being like the whirring of a very large motor with a deep tone. I looked steadily at the point it seemed to come from, but could see nothing, possibly, or probably, owing to the thin rising mist" The Rev. E. F. Hutchings, of Market Hill, Co. Armagh, says "that a great rumbling sound was heard there on Thursday, April 10th, at about 11 o'clock a.m. (Dublin time), and lasted about eight seconds. I have no doubt whatever but that it was of seismal origin, it being a full round booming sound, pervaded by a regular wavy rumbling There was an absence of any crashing, detonating, or rippling sound, such as more or less distinguishes the explosion of meteorolites. There was no tremor in the ground or air that I could perceive, but a boy of eleven years, working in a garden when he heard the sound, ran and said the garden was shaking."

There appears to be no doubt, however, that from the near correspondence in time between the rumbling sound and the visible disruption of the fireball, that the whole phenomenon was meteoric. It will be interesting to hear of further observations of the fireball, which seems to have been a particularly brilliant object, even in the presence of the sun, over the north-east region of Ireland. As seen from Dunsink, the meteor disappeared at an estimated altitude of 10°, and if its position was then over Tyrone, in the neighbourhood of Dungannon, its height must have been 15 miles. The probable radiant point would be in Pegasus, near β Piscium, or in the eastern region of Aquarius if the direction of the fireball's flight was from the zenith to near the northern horizon, as observed at Dunsink.

Large Meteor.—Mr. G. Fisk, of Eccleshill, Bradford, writes that he observed a meteor brighter than Venus on April 20th, 10h. 42m. It appeared to shoot from near α Draconis, and disappeared near γ Ursae Minoris. It was intensely blue in colour, and cast a distinct shadow, though the moon was almost at full. Duration of flight, about $1\frac{1}{2}$ seconds. It left very little trail. This meteor, though it appeared on the date when Lyrids are unusually numerous, was directed from the region of ζ Ursae Majoris and α Canum Venaticorum, so that it could not have belonged to the periodical shower of April.

THE FACE OF THE SKY FOR JUNE.

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

The Sun.—On the 1st the sun rises at 3.51 a.m., and sets at 8.4 p.m. On the 30th he rises at 3.48 a.m., and sets at 8.19 p.m.

Summer commences on the 22nd, when the sun is at the solstice, on which date he remains above the horizon for 16h. 35m.

Sunspots are infrequent; at the time of writing the sun's disc is devoid of spots.

THE MOON:—

		Phases.	h. m.
June 6	●	New Moon	6 11 A.M.
„ 12	☽	First Quarter	11 54 P.M.
„ 21	○	Full Moon	2 17 A.M.
„ 28	☾	Last Quarter	9 52 P.M.

			h.
June 6	☾	Perigee	5·2 A.M.
„ 19	☾	Apogee	4·9 P.M.

The following are the particulars of stars occulted during the month and observable at convenient hours:—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h
June 15	86 Virginis	6·0	10 15 P.M.	110	89	11 31 P.M.	285	255	9 17
„ 18	ν Scorpii	4·5	9 37 P.M.	118	125	10 59 P.M.	261	255	12 16
„ 21	D.M.-19°5134	6·5	9 7 P.M.	92	122	10 23 P.M.	264	285	15 16

THE PLANETS.—Mercury is an evening star, and during the early part of the month is fairly well placed for observation. On the 1st he sets due N.W. shortly after 10 P.M., or two hours after the sun. On the 10th he sets at 9.25 P.M., or a little more than an hour after sunset. He is at the stationary point on the 11th, in aphelion on the 18th, and in inferior conjunction with the sun on the 23rd.

Venus is a morning star, but is not very well suited for observation as her brightness is diminishing. About the middle of the month she rises in the E.N.E. shortly before 2 A.M.

Mars is also a morning star, but does not lend itself to easy observation as he only rises in the early dawn about an hour in advance of the sun.

Jupiter is still in Capricornus, and is becoming more accessible for observing purposes. About the middle of the month he rises shortly after 11 P.M., and comes to the meridian about 4 A.M. The apparent diameter of the planet is increasing, being 39″·6 on the 1st, and 43″·0 on the 30th. He is stationary on the 6th, after which he describes a retrograde path, thus accelerating his diurnal return to the meridian.

Uranus is visible throughout the night, rising about 8.45 P.M. on the 1st, and about 6.40 on the 30th. He is

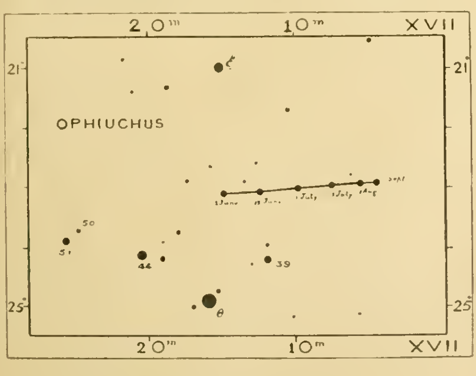


Chart showing Path of Uranus

in opposition on the 11th. The planet is situated a little north of θ Ophiuchi, as is shown by the chart below, which should enable it to be found readily. It shines with the brightness of a 6th magnitude star, and can be made out on clear moonless nights with the naked eye, but, aided by a pair of opera-glasses, it is easily discernible.

Saturn is becoming more favourably situated for observation. During the month the planet describes a short westerly path in Sagittarius, near the border of Capricornus. On the 1st he rises at 11.10 P.M. and transits at 3.23 A.M., whilst on the 30th he rises at 9.10 P.M. and souths at 1.22 A.M. The apparent diameter of the planet is 16″·8, whilst the major and minor axes are 42″·0 and 15″·5 respectively.

Neptune is not observable, being in conjunction with the sun on the 23rd.

THE STARS.—Position of the stars about 10 P.M.:—

ZENITH . Great Bear, Cor Caroli.
NORTH . Ursa Minor, Cepheus, Cassiopeia.
EAST . Cygnus, Lyra, Aquila, Sagittarius.
SOUTH . Hercules, Ophiuchus, Corona, Libra, Scorpio.
WEST . Leo, Cancer.—S.W.: Virgo and Bootis.—N.W.: Capella.

Chess Column.

By C. D. LOCOCK, B.A.

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

Solutions of May Problems.

No. 1.

"Per Aspera ad Ardua."

Key-move.—1. Q to R6.

If 1. . . . K to B4,	2. Q to R5ch, etc.
1. . . . K to Q5,	2. Q to B6ch, etc.
1. . . . B to B5,	2. Q to Kt7ch, etc.
1. . . . P to B7, etc.	2. Q to Kt5ch, etc.
1. . . . R to Rsq, ch,	2. P × R(Q) ch, etc.
1. . . . Kt to B6, etc.	2. R to K2ch, etc.

[There is a dual after 1. . . Kt to K7 by 2. R × Ktch, or 2. Q to Kt5ch.]

No. 2.

"Fort Nachanand."

The author's solution is 1. Kt to R5, but this fine problem is unfortunately cooked by Q to R5ch.

No. 3.

"Algol."

Key-move. —1. P to Q4ch.

If 1. . . . K to Q4,	2. Kt to K7ch, etc.
1. . . . K to Kt4,	2. Q to QKt7ch, etc.
1. . . . K × Kt (B5),	2. B to Kt3ch, etc.
1. . . . K × Kt (B3),	2. B to R4ch, etc.

[A near 'try' by 1. B to R4 is defeated by 1. B to K4].

SOLUTIONS received from W. Nash, 5, 6, 4; Alpha, 4, 0, 0; W. Jay, 5, 6, 4; G. Woodcock, 4, 4, 4; G. W. Middleton, 5, 4, 3; "Endirby," 5, 4, 4; W. de P. Crousaz, 4, 4, 4; G. A. Forde (Captain), 0, 0, 0; W. J. Land, 0, 4, 0; J. Y. Fullerton, 4, 4, 0; "Tamen," 5, 0, 4; "Cowslip," 5, 4, 4; J. Sowden, 4, 4, 0; C. Johnston, 4, 4, 4; "Looker-on," 5, 3, 4; A. F. (Rugby), 0, 0, 0; H. D'O. Bernard, 5, 4, 4; J. W. Dawson, 4, 4, 4; H. Boyes, 4, 4, 0.

It is possible that some solutions may have gone astray, and may be received after this page has gone to press. It would save much trouble in going through solutions if correspondents would refrain from the complete analysis which some appear to think necessary. Post-cards are preferred, and duals and claims for second solutions should be clearly indicated. Some solvers have sent in claims for duals on the third move, but these, under the conditions, do not count.

Composers of "Leonard" and "All's well that ends well."—Corrections received, and will be made accordingly.

Norseman.—April solutions correct, but too late to acknowledge.

Composer of "Vega."—Since you have sent your name and address it would be impossible to insert the problem.

G. S. Johnson.—As pointed out in my reply to you last month, a problem cannot be admitted to the tournament when the conditions as to sealed name and address have not been observed. Nor could any correction be received in the case of a problem which has been shown in this column to be unsound.

H. D'O. Bernard.—In the circumstances I think that your solutions may be accepted for this occasion.

G. F. Todd.—I fear that your solutions were too late to be counted.

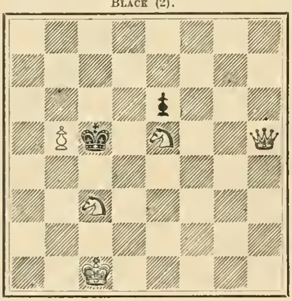
Alpha—Your revised solution of No. 3 is quite correct, but too late, as you say, to count. I quite understand that you are not a serious competitor, but solutions must be acknowledged on a uniform system.

PROBLEMS.

No. 4.

"Three steps and a shuffle off."

Black (2).



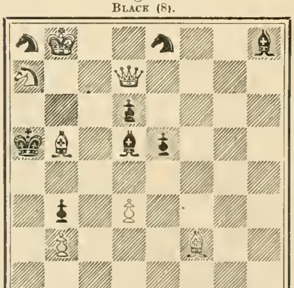
White (5).

White mates in three moves.

No. 5.

"Englisch."

Black (8).



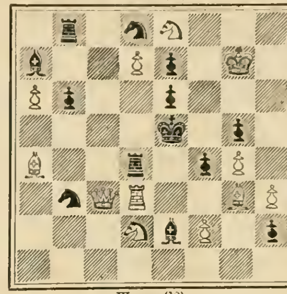
White (7)

White mates in three moves.

No. 6.

"Trifolium Duplex."

Black (13).



White (12).

White mates in three moves.

CHESS INTELLIGENCE.

A match between Scotland and the Northern Counties was played last month at Manchester, with twenty-two players on each side. Scotland were defeated by 15½ games to 6½.

The Cable Match between the American Universities and a combined Oxford and Cambridge team resulted in a rather easy victory for the Americans, the score being as under:—

U.S.A.		England.	
C. T. Rice (Harvard)	1	H. A. Webb (Cambridge) ...	0
F. H. Sewall (Columbia) ...	1	W. M. Grundy (Oxford) ...	0
J. F. Sawin (Yale)	1	H. F. Davidson (Oxford) ...	0
J. B. Hunt (Princeton) ...	1	F. W. Clarke (Cambridge) ...	0
H. A. Keeler (Columbia) ...	½	H. Bateman (Cambridge) ...	½
J. Adams (Yale)	0	H. D. Roome (Oxford)	1
	4½		1½

The *Literary Digest* announces a Problem Tourney, for two-move and three-move problems, the first prize being a handsome silver cup. Problems must reach the Chess Editor, 30, Lafayette Place, New York City, N.Y. (U.S.A), by July 1. A solution tourney will be held in connection with the problem tournament.

The Southern Counties Championship contest is drawing near its conclusion. Gloucestershire have come out at the head of the Western Section, with victories over Devon, Somerset, and Wiltshire.

All manuscripts should be addressed to the Editors of Knowledge, 326, High Holborn, London; they should be easily legible or typewritten. All diagrams or drawings intended for reproduction, should be made in a good black medium on white card. While happy to consider unsolicited contributions, which should be accompanied by a stamped and addressed envelope, the Editors cannot be responsible for the loss of any MS. submitted, or for delay in its return, although every care will be taken of those sent.

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

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

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CONTENTS.

A CHART OF THE HUMAN HAIR-STREAMS, SHOWING THEIR LINEAGE AND HISTORY.

By Walter Kidd, M.D., F.Z.S.

The interrogation of Nature is the richest seed-plot of science, and those who cultivate it are rewarded in due time if only their foundations be "well and truly laid." Whatever the answers may be, they will never be other than true, and we must needs abide by the result of our interrogation. No oracles are delivered by Nature's voice, rather does she teach by the Socratic method of questioning her learners. Thus it is that, since the genius of Hutton opened up the way into the new world of geology, there are geological problems staring us in the face as we pursue our way on this planet, some inviting or compelling enquiry, some suggesting complicated and, perhaps, hopeless study. It is not less so with biology, which a greater than Hutton has illuminated, and where still the unknown but knowable meets the naturalist on every hand.

To the simpler class of problems belong those facts of the direction of hair on the human body, open to the study of most of us on our own persons or on that of any young hairy subject. Those who have not looked particularly into the matter are not aware that, in addition to the well-known hairy regions, every inch of the human skin is clad with fine hairs, except the palms of the hands, soles of the feet, third phalanges of the fingers and toes, and one or two other small areas. The character of this growth varies from a covering of hairs, so minute that a good lens is needed for their detection, to a profusion of long hair of a Simian character, reaching its maximum in the Ainu or hairy aborigines of Japan.

It is agreed to look upon this hairy covering as a vestige of one which was of use to man's hairy, arboreal, ape-like ancestors, and to consider it as in process of disappearance. Whatever view we may take of its value, it cannot but be subject to natural laws, and the canons of investigation applied to other facts of Nature must be applied in this small instance also.

The rate of growth of the human hair, on the head at least, is an inch in two months, and it is probably less on the general surface of the body.

The hairs are inserted in the skin at an acute angle on every part of the body except the eyelids, where they are at right angles to the surface, and wherever they are found the hair-tracts have a constant direction for that region. This sloping direction of hair is common to nearly all lower animals, the mole being the most marked exception, and the question cannot but suggest itself: Is this slope adapted *to* the needs of the animal or man, or is it adapted *by* their habits? This debatable point cannot be dealt with here.

It is proposed here to study the direction of the human hair-streams and the causation of their various peculiarities. Broadly speaking these streams, according to their range, show two things about man: first, what he has been; secondly, what he has done; or, in other words, his ancestry and his habits of life.

The point which strikes one first in examining the chart of these hair-streams is the very complicated direction taken by them on the head, neck, and trunk, and on the upper extremity, and the equally marked simplicity of the direction of those on the lower extremity. Certain of the former literally demand enquiry as to their cause, on the sound principle that every phenomenon in Nature is to be looked upon as capable of explanation, whether by the light of present knowledge, or by future methods of discovery. It is not necessary to employ hypothesis at all extravagantly or to wait indefinitely for further light in explaining most of these peculiarities in question. They may be open to explanation by one of three hypotheses:—

1. They may have been created with the rest of man's physical frame, as an adaptation to his habits or certain of his needs. This view will hardly commend itself in the light of present knowledge. Apart from other reasons, the direction in which the human hair slopes in the greater part of his body is immaterial to his comfort or well-being.

2. Adaptation and natural selection in the struggle for life might help us. Here, again, the question of utility is involved if such views are to be maintained. It is strange to find such a statement as the following in an important work for students on Physiology by Mr. Leonard Hill, who says without any reserve: "The fine hairs on the body and limbs of man are arranged, as in the monkey,

to point in certain directions so as to shoot off the rain from the body when climbing."*

This statement is not only contrary to reason but to the facts of the case, as may be seen at once on reference to the figures, *e.g.*, at the back of the neck, the front of the neck, the chest, the back of the trunk, and the outer surface of the arm as far as the middle. These few regions alone are enough to disprove Mr. Leonard Hill's statement.

In considering man's present covering of hair it is not necessary to prove that, except in one or two exposed regions where sexual selection may operate, selectionist views as to the cause of the peculiarities in question cannot hold. If it could be shown that they were survivals of hair-slope useful to Simian ancestors, the case would be different, but a glance at the figures shows this not to be the case, and some other cause for them must be sought.

3. They may have been modified from a simple type of hair-slope through use-inheritance, and this is the view held here.

According to the received view of man's physical descent his prototype must have been Simian in form, partially assuming the erect posture, and perhaps combining some of the characteristics of each of the four genera of existing anthropoid apes.

It follows then that he possessed a hairy covering little differing from that of a gibbon or a chimpanzee. In other words, the primitive stock of man showed a simple and very slightly differentiated covering of hair, whose direction was, broadly speaking, from the cephalic to the caudal end of his trunk, from the proximal to the distal end of his limbs, and on his head the hair-streams either parted in the centre like those of a chimpanzee, or passed backwards from the projecting eyebrows over the low frontal and parietal regions, and fell down his neck in a vertical direction. An hypothetical diagram of this hairy covering may be constructed, and is shown in Figs. A, B. If this representation of the primitive hair-slope of man's early ancestors be not allowed there is an end to the validity of comparative anatomy, and the findings of that great science are set aside in this instance as not agreeing with certain other tenets. But I may safely take it that the direction of hair indicated in Figs. A, B, cannot be challenged except in some entirely unimportant details. There is an illustration in "Living Races of Man," Part IV., p. 110, which is most suggestive on this point, the dorsal surface of the body of a girl two years old being figured and showing a very primitive covering of thick long hair arranged exactly as the hair of a gibbon is arranged, and this would seem to be a reversion to type and a latter-day illustration of the manner in which man's hairy prototype had his hairy covering disposed. The contrast in this illustration between the hair-slope of the case in point and that of man, as we know him, is very striking.

The main tracts of hair on the body of man are represented on the accompanying diagrams and indicated in outline by arrows which point in the direction assumed by the hair-stream of the parts covered by these arrows. Any verbal description of these would be superfluous, and it is only necessary to point out that the diagrams illustrate the normal directions of man's hairy covering, and that these are remarkably constant, whether in the fœtus, as described in 1839 by Eschricht, and 1857 by C. A. Voigt, or in newly-born infants that I have examined, or in hairy young adults, and even in older subjects whose hair has not been worn off by friction. The only difference between the direction of hair in an infant and an adult is that the specially human peculiarities are more pronounced in an adult.

These hair-streams may be classified, bearing in mind the direction of hair of man's early ancestors, and its altered direction at the present day, into :—

1. *Primitive*, derived from ape-like ancestor, marked by arrows with single heads ;
2. *Acquired* (A) By morphological change, marked by arrows with two heads ;
   (B) By habit or use, marked by arrows with three heads.

The division of man's hair into separate streams is, of course, an artificial one, but is justified by a reference to the diagrams, which show that the arrows merely indicate the main direction in which a certain tract of hair separates itself from surrounding tracts.

Two considerations must be always kept in mind in studying man's hair-slope: first, that it must be looked upon as a *stream*; secondly, that in accordance with analogy, *it moves in the lines of least resistance*. As the hairs are set at an acute angle and the rate of growth is about an inch in two months, and as the growth consists in the shaft being pushed out of the hair-follicle by changes there, until its normal length is attained, when the end wears off, there are present just those mechanical conditions needed to produce a *slowly moving stream passing in the lines of least resistance*. The best illustration of this process afforded by nature is a glacier, though the forces in operation are of a different kind, and I would suggest that the direction taken by the hair of man in many regions of his body is governed as much by purely mechanical laws as the windings of a glacier, and is equally far removed from the province of adaptation to needs and selection.

On the *head* the chief peculiarities are correlated with morphological change, except at the edge of the scalp, where varying methods of dressing the hair have availed to produce a remarkable series of peculiarities found even in infants, which cannot be here detailed.* Two are shown in Figs. E, F.

The *face* presents certain changes from Simian type probably due to sexual selection.

The *external ears* conform rather closely to a Simian arrangement.

The *neck* presents in front a remarkable reverse of slope at the level of the larynx (Fig. C), which can only be due to some special human habit or use. It occurs closely at the spot where any clothing worn round the neck terminates, and as may be seen in the neck of a man with a beard not too long, the influence of clothing *does* tend to draw the lower portions of the neck-streams upward.

At the back of the neck two well-marked arrangements (Figs. G, H) are to be noted, and these occur about equally frequently in this country in any given number of persons. It would appear that no other cause than varying methods of dressing the hair in this "critical area" of the hair-streams can have produced such entirely non-Simian changes.†

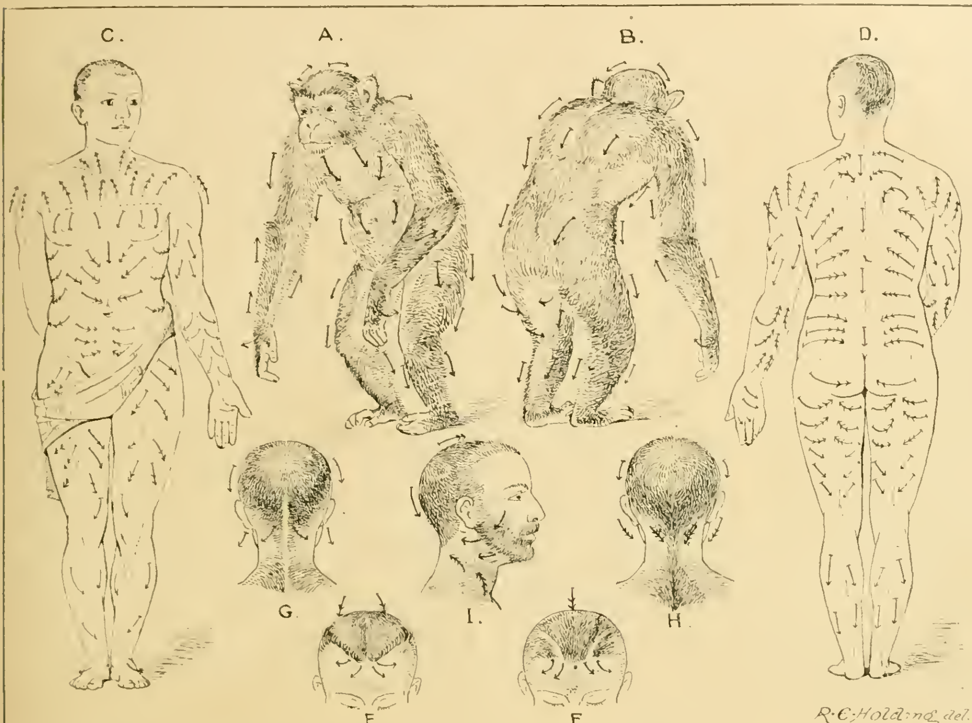
On the *chest* in front a remarkable arrangement is shown in the Fig. C. The point of departure upwards of the streams which go to form those of the neck, is found with singular uniformity at the level of the second costal cartilage or second intercostal space. It is said in Lydekker's "Royal Natural History" that something of this arrangement is found in the gorilla. It is otherwise in the young specimen at South Kensington, and not

* *See* "Manual of Physiology," p. 324.

* *See Proceedings* of Anatomical Society of Great Britain and Ireland, 1902.

† *See* "Journal of Anatomy and Physiology," Vol. XXXV., pp. 311, 312, 313; and "Use-Inheritance," Walter Kidd. (A. and C. Black. 1901.) pp. 39, 40.

visible in the other three adult specimens. In producing this human peculiarity clothing is probably the efficient cause. It is easy to see that in respiration, which involves much movement of the upper ribs, a force is acting in inspiration and absent when the chest falls in expiration, calculated to draw the growing stream of hair in this, the line of least resistance. Here is an adequate cause acting exactly corresponds to the direction which would be induced by the normal attitude of man in sleep, viz., on one or other side and with the head, and perhaps the shoulder, raised on a pillow. Here, again, as there is a force calculated to produce what we find existing for about a third of a human being's life, it is unnecessary, according to "the law of parsimony," to go beyond such an explanation.



Two views (A and B) of the assumed prototype of Man, showing the primitive direction of hair.

Seven views (C. D. E. F. G. H. I) of Man's body.—Primitive tracts of hair shown by arrows with single heads. Those acquired by morphological changes marked by arrows with two heads. Those acquired by use and habit marked by arrows with three heads.

during two-thirds of man's life, *i.e.*, during daytime, when the effects of pressure against clothing would come into play.

On the lower part of the *chest* and the front of the abdomen such changes as are found are probably due only to morphological change.

The side of the *abdomen* shows the singular parting-line, figured (Fig. C) as extending from the axilla to the level of the umbilicus, here sometimes terminating in a whorl and, in most cases, extending to the groin. This wholly human peculiarity is most probably accounted for by the fact that in sleep on one or other side, which is the greatly predominant attitude, the arm lies along this parting and determines the separation of the abdominal and dorsal streams in accordance with the principle that these flow in the lines of least resistance.

On the *back* the direction of hair in man and his prototype are markedly contrasted. The upward slope shown The equally strange slope of hair which is seen at the back of the arm-pit is also directed in a way which this force referred to would produce. In addition to the mechanics of the position during sleep, the mechanical effect of sitting with the back leaning against any support emphasizes the existing direction on the shoulders and upper part of the back. Our Troglodyte ancestors cannot well have been luxurious persons, but even they must have had many hours of their strenuous lives free enough to lean against the trunk of a tree, the side of a cave, or some bank of earth, and when we come to the case of modern man, the opportunities for such indulgence have been obviously much increased.

On the *upper extremity* the complicated slope of hair strikes one on looking at Figs. C, D. On the upper half and outer side the singular upward direction which begins at the insertion of the deltoid is clearly of the same nature and due to the same causation as the peculiarities on the back. The lower half and most of the forearm are equally Simian and simple. The only exception on the forearm is the reversed slope on the extensor surface, due, I submit, to the resultant of two forces, a downward and forward one, acting when this part of the limb rests on any object, as it frequently does. This point does not distinguish man much from apes and monkeys, and in all of these groups similar mechanical forces operate to produce it, including in the latter the effect of tropical rain, in their arboreal lives. I have referred at much more length to the causation of this hair-slope elsewhere,* and need only say here that it is more probable that adaptation *by* habits and use is a far more intelligible cause for it than any adaptation *to* the needs of the animal on which selection might act. This peculiarity is found very marked in carnivores, such as a short-haired dog, and ungulates such as certain antelopes, which lie with their fore limbs planted in front of them, in the very attitude calculated to *produce* this slope.

On the *lower extremity* the direction of hairs is as simple and primitive as that on the upper is complicated and acquired. The only area worth noting is the upper third of the back of the thigh, where the effect of the sitting attitude is clearly able to produce the direction indicated. On the rest of this limb so few forces act on the skin surface with any uniformity that it has retained its primitive slope of hair.

It is worth noting that the theory of use-inheritance carries with it the view that the effects of *disuse* are inherited, and this is remarkably illustrated by the way in which in a very hairy subject, the growth of hair on the leg ceases sharply at a point opposite to the ankle-joint. It is difficult to see how any other influence than that of the friction of a shoe or low boot can produce this sudden transition from a hairy leg to a nearly hairless foot. The contrast also in a very hairy man between the great amount of hair on the back of the hand and the appearance of scattered long hairs on the instep of the same subject is most suggestive.

In addition to any interest possessed by these facts, they have a bearing on heredity. The inference to be drawn from them seems to be that acquired characters may, and in this case are, inherited. If the descent of man be what it is claimed to be, he has somehow acquired and transmitted a very remarkable series of changes of hair-direction. It would seem that these can only have arisen through habit, use, and the action of environments, and by disuse, and that any reference of them to selection is estopped. There is no hair-tract of the human body diverging from the ancestral type of slope which has not an adequate and ascertainable mechanical force to which the facts may fairly be attributed.

The illustrative plate has been prepared under my direction by Mr. R. E. Holding, who has greatly assisted my demonstration of the subject.

* *Proc. Zoological Society*, London, June, 1900, pp. 676 77; "Journal of Anatomy and Physiology," Vol. XXXV., p. 319; "Use-Inheritance," pp. 28–33.

FORE-LEGS AND THEIR USES.

By E. A. BUTLER, B.A., B.SC.

THE common lobster furnishes one of the best possible illustrations of a curious principle that finds expression in the organization of animals whose body, like its own, is composed of a succession of segments with jointed appendages, or in other words, animals belonging to the great sub-kingdom Arthropoda. The principle in question is that the paired appendages of the different segments, though all constructed upon the same plan, may become so modified in form as to be adapted to the discharge of the most diverse functions. And so we find that in this particular animal these appendages subserve the functions of progression, whether by walking or swimming, of attack and defence, of manipulation and mastication of the food, and of sensation of various kinds. Amongst insects, too, which are equally arthropodous animals, we find that those appendages which have assumed the character of limbs, and are, as a rule, adapted for locomotion of some kind or other, may yet, by still further modification of their form, become well suited for the performance of other functions quite remote from their original purpose. It is the first of the three pairs of legs with which an insect in its adult condition is furnished that exhibit this peculiarity in the greatest degree, and I propose in this paper to consider in detail the varied functions which are discharged by these same limbs amongst British insects.

We may distinguish in these fore-legs six different types, which are generally distinct, not merely in function, but also in shape and appearance. They may be called the ordinary locomotive type, the prehensile, the raptorial, the fossorial, the auditory, and the brush type; or, to put it in other words, insects may use their fore-legs to aid them in walking or running, in clasping and retaining their mates, in catching their prey or in steadying it while it is being devoured, in digging through the soil, and even in listening to insect music, or again, their front legs may be shortened and covered with a dense mass of hairs so as to look like a brush, and to be quite useless for walking.

By far the greater number of insects of course use their fore-legs as they do the other pairs, for locomotive purposes, and we may consider the locomotive as the normal type of leg, and the rest as modifications of this. As we shall have to make frequent reference to the different parts of the leg, it is very desirable that the few technical terms it will be necessary to use should be thoroughly grasped once for all, in order that the rest of the paper may be intelligently followed. What then is the construction of the ordinary locomotive leg? It is composed of five parts (Fig. 1). Beginning where the leg joins the body, we find first, the *coxa*, a joint which varies very much in shape, but always attaches the leg to the general armature or external skeleton, in a cavity into which it exactly fits. The shape of the coxa and the method of its attachment determine the directions in which the leg as a whole can move, and fix the limits of its action. A small joint comes next, called the *trochanter*. This is succeeded by the two main divisions of the leg, viz., the thigh or *femur*, and the *tibia* or shank. Finally we have a set of two, three, four, or five small joints, called collectively the *tarsus*, or foot, and at the end of the last joint there is usually a pair of hooked claws. The tarsus is the only part of the leg that comes in contact with the ground, and its many jointed condition gives it the necessary flexibility for securing firm foothold when the insect is travelling over uneven surfaces, as would usually be the case. At the points of junction of the different divisions of the leg, the bend is successively in opposite directions, just as in our own limbs. Thus the

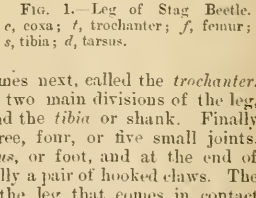


FIG. 1.—Leg of Stag Beetle. *c*, coxa; *t*, trochanter; *f*, femur; *s*, tibia; *d*, tarsus.

femur bends up from the coxa and trochanter, the tibia bends down from the femur, and the tarsus bends up again from the tibia, so that the angles caused by the bending are alternately on opposite sides of the leg. The figure shows this very well.

A little thought will show that the exact method in which these legs are used must differ according to the position of the leg on the body. Roughly we may say that the fore-leg pulls the body forward, while the hind-leg pushes it, and the middle one serves as a sort of pivot or balancing point. The general rule in walking or running seems to be that the first and third legs of one side, and the middle one on the other, are put forward simultaneously, or nearly so, for the first step, and then are followed by the other three for the next, so that the insect proceeds by means of two tripods which are planted on the ground alternately. In taking a step forward therefore, the right fore-leg, say, will be advanced, and with it or immediately after it the left middle leg and the right hind leg. In advancing the fore-leg, however, the limb is of course stretched out to the full, and as the body moves forward, the joints of the legs close up. The reverse is the case with the hind leg. This is in the contracted condition at the beginning of the step, and is opened out as the step proceeds, thus of course acting as a thrust behind, while the fore-leg exerts a pull in front.

As a rule these movements are effected with very great rapidity, so that the eye can hardly follow them, and hence it is no easy matter to verify the above statements by merely watching a moving insect. A good deal of patience and mental concentration is required to watch six moving objects simultaneously, and determine the order of their movement, even when it is not very rapid, and in most insects it is far too rapid to admit of a determination in this way. If, for example, the observer were to try the experiment on a kitchen cockroach, following it about and keeping his eyes steadily upon it all the time, he would probably be conscious merely of a dazing motion, tiring to the eye and defying analysis, and his patience would be exhausted long before he could satisfy himself as to the true scheme of progression. But by photographing the insect at exceedingly short intervals of time, a minute fraction of a second in fact, on a revolving film, a series of silhouettes is obtained of the different phases of a single step; this is evidently equivalent to a slowing down of the movement till it can be followed with the eye, and thus it is possible to determine the order in which the legs are advanced and progression takes place.

Our second type of leg is that which may be described as the prehensile one. This is a sexual characteristic confined to the males, and is found fully developed only in a small number of insects. The foot is converted into a sort of clasping organ, and, in fact, becomes a kind of hand, by which the suitor is able to secure and retain his mate. In certain water beetles the method of adaptation is that of a great expansion of the basal joints of the tarsus, whereby a kind of suction pad is formed which is sometimes of great beauty and delicacy of construction. The most remarkable and beautiful example is that of the great carnivorous water beetle (*Dytiscus marginalis*). In the male of this insect (Fig. 2, A) the three basal joints of the tarsi are enormously broadened and made to fit close together so as to form a circular pad. On the upper surface there is nothing very remarkable about this except its size; it looks as though the insect had been a martyr to rheumatism or gout, and so had got its joints swollen beyond recognition. But on the underside these pads are marvels of complexity and grace. Their surface is very thickly set with what appear to be extremely modified hairs. Two of these form circular cup-shaped discs, the largest of which is about $\frac{1}{25}$ inch in diameter. The circumference of the discs is margined with fringed hairs. The rest of the surface is closely covered with very much smaller trumpet-shaped hairs, which are present in considerable numbers, and the whole pad is thickly fringed with simple hairs round its edges. All this collection of trumpets, cups, and fringes acts as a complex sucker, and

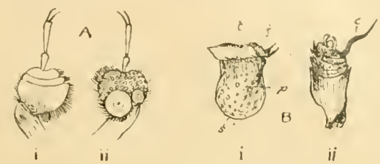


FIG. 2.—A. Fore-foot of male *Dytiscus*. (i) Upper-side. (ii) Under-side.

B. Fore-leg of male *Crabro cribrarius*. (i) Tibia. (ii) Tarsus. *t*, tibia; *s*, shield attached to tibia; *f*, thigh; *p*, projection from thigh beneath the shield, appearing faintly through it; *c*, claw.

adheres to the back of the female insect, the surface of whose wing-covers is roughened by longitudinal furrows, and thus rendered easier to hold. Another very common water-beetle, flatter and rounder in shape, and called *Acilius sulcatus*, is furnished with similar fore-feet, but these two, with perhaps another common *Dytiscus*, are almost the only insects commonly met with that possess this peculiar apparatus.

In the great black vegetarian water beetle, *Hydrophilus piceus*, a slightly different arrangement occurs; its fore-feet are modified, it is true, and for similar purposes, but in a different way. Here it is the last tarsal joint that is enlarged, and not the basal ones. This last joint forms a great triangular disc, but it is not furnished with trumpets and suckers.

Amongst the order Hymenoptera, a very peculiar modification may be seen in certain species of the so-called "sand-wasps." *Crabro cribrarius* is one of the most remarkable of these. It is a shining jet-black insect with its body banded with bright yellow; it is commonly found in sandy localities, where it forms its burrows in the ground, and in the cells it constructs for the rearing of its brood, it stores up flies of different kinds as food for the young larvæ which will in due course be hatched from its eggs. The male of this insect has so extraordinary a pair of fore-legs (Fig. 2, B) that when one first sees them one finds it difficult to believe that the insect is not suffering from a deformity, and it is only on noticing the distinct outlining of the different parts and the exact correspondence of the two legs, that one becomes convinced that one is dealing with a natural structure. The whole length of the leg is affected more or less, and every joint is modified in some extraordinary way. The thighs are short and swollen, and produced behind into a most fantastic, five-sided and rather twisted projection, near to which is a sharp spine. Then the tibiæ are expanded all along their outer edge, so as to make a large shallow cup like a shield, the surface of which is discovered, on holding it up to the light, to be a kind of network with the meshes filled in for the most part with a dark, but here and there with a transparent membrane; the aforesaid projection from the thighs runs into the hollow of this shield, and looks as though it were intended as a support for the latter; the tarsi again are much dilated, and they terminate in two unequal claws, the inner one of which is very long and curiously twisted. The whole apparatus is about as remarkable and complicated as anything to be found throughout the Insecta. Several other insects, closely allied to this one, are modified more or less in the same manner, each one, however, with a pattern peculiar to itself.

The third type of fore-leg is what I have called the raptorial, by which is meant that the peculiar formation of the fore-legs has regard not to locomotive requirements, but to the capture of living prey. In several instances the fore-legs are used for this purpose without any special modification of form. This is notably the case with the group of water bugs called "skaters," which may be seen any day sitting on the surface of a pool, with their thin long median and hind legs outstretched and ready to start off at a moment's notice, skating over the water out of harm's way. These two long hinder pairs of legs are set on at right angles to the axis of the body and in a horizontal plane, in which the whole of their movements take place, but the fore-legs, which are much shorter, are set on in the usual way, and as the insect sits upon the water, balancing itself by its outstretched skating legs, its short fore-pair rest with their tarsi only on the surface. And here we see the advantage of having three pairs of legs. Two pairs are quite enough to steady the animal on the water and keep it in position, and then the third pair is available for any other duties, for in fact, these fore-feet seem to be as useful as hands. By rubbing the antennæ and beak between them, these important organs are kept clean and tidy, and further, these same limbs are useful for seizing the flies and other small insects that frequent the surface of the pond, and holding them in position while their juicy bodies are being drained dry by the sharp beak of their captor. No particular modification of form is requisite in such a case.

But the water scorpions, which live at the bottom of the pond, and could not conveniently manage in the same way, have their fore-legs very remarkably altered both in form and in the direction in which they can move. As one of these insects was described in our last paper, we may now take as our illustration its much commoner relative, the Common Water Scorpion (*Nepa cinerea*). This is an abundant insect in almost any pond, at least in England. It cannot possibly be mistaken; the extreme flatness of its body, the curiously curved shape of its fore-legs, and its long tail filaments will enable it to be recognised at a glance. The first peculiarity we notice about the fore-legs (Fig. 3) is that they move horizontally, and hence would

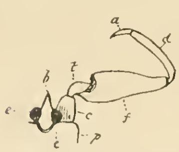


FIG. 3.—Head and Fore-leg of Water Scorpion. *b*, head; *e*, eyes; *p*, thorax; *c*, coxa; *t*, trochanter; *f*, femur; *d*, tibia; *a*, tarsus.

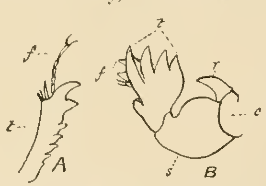


FIG. 4. A. Fore-leg of Dung Beetle. B. Ditto of Mole Cricket. *c*, coxa; *r*, trochanter; *s*, femur; *t*, tibia; *f*, tarsus.

be useless for walking purposes; this change in direction, however, gives them a splendid power in the seizure of prey, for, working from side to side as they do, their ends meet in the middle and grip as by a pair of pincers any object that happens to lie between them. The coxæ are stout and strong and project from the body straight forward on each side of the beak. The trochanter is much larger than usual and serves to turn the corner so as to enable the next part of the leg to stretch out sideways. The femur is by far the largest and longest part of the leg, and its inner edge carries a distinct groove, the use of which will appear presently. The tibia and tarsus together are only as long as the femur, and they are so placed as to curve round from the end of the femur towards each other, so that they can meet straight in front of the head. When not in use they are folded inwards along the edge of the femur, fitting most accurately into the groove aforesaid, just in the same way as the blade of a pocket knife shuts back into the handle. The tarsus itself ends in a sharp-pointed claw. Such is the limb which by slight alterations of form has been transformed from a simple harmless walking implement into a murderous weapon by which living creatures can be seized and brought to the mouth, while their juices are abstracted by the short and sharp beak.

The next type of leg is the fossorial, or digging, one. Many insects that burrow in the ground use their jaws for nibbling away the earth, but others employ their legs, and particularly the fore-pair, in scooping out the soil and so working their way along, and there are certain modifications of structure by which a fossorial leg can always be easily distinguished. The many-jointed foot would of course be too yielding to serve as the digging implement, and hence the duty is handed over to the next part, viz., the tibia, or shank. In digging insects the tibia is strong and stout, and furnished on the outer edge with very hard and powerful tooth-like projections. It is chiefly amongst the order Coleoptera or beetles that these digging legs are found, and they attain their most characteristic development in the group of dung-beetles (Fig. 4, A)—hard-bodied insects that inhabit the droppings of horses and cattle, and are most useful as scavengers. They habitually lie buried in the dung, and their digging legs are of great assistance to them in working their way into and through the mass. In the case of the largest examples, such as the "Watchmen," or "Dor" beetles, these legs further aid in an elaborate process of well-sinking, which is needed for the proper location of the eggs. Beneath the mass of dung, the female beetle excavates a deep and very accurately formed cylindrical burrow, at the bottom of which she places a store of the dung together with one of her eggs. This is destined to hatch in about a week's time, and the young grub therefore finds itself started in life with a well-furnished larder, the contents of which it can proceed lazily to enjoy.

In all these digging beetles, the tarsi are a good deal reduced in size and enfeebled in power, and one can readily understand the possibility of their ultimately becoming practically useless, and so being more or less aborted, for as the tibiæ increase in size and power, the insect would depend more and more upon them and less and less upon the tarsi, which, indeed, might, it would seem, get in the way of the digging operations. Such a stage as this has, in fact, been reached in another insect, belonging to quite a different order, the mole-cricket (*Gryllotalpa vulgaris*), a member of the Orthoptera. This insect is as well adapted for burrowing as the little quadruped from which it gets its name, and the modification of the fore-limbs has, in the two cases, proceeded on similar lines. In the mole-cricket (Fig. 4, B), the tibia is enormously broad and strong, and ends in four very powerful teeth which give it the appearance of a hand, and it forms as good an excavating implement as the wonderful hand of the mole itself. The muscles required to work this powerful implement need safe lodging and strong attachment, and hence the femur too is widely dilated, and is almost as stout and strong as the tibia. On the other hand, the tarsus has dwindled away to a most insignificant size, and has been shunted on one side where it lies underneath the tibia; in fact, it is not likely to be noticed at all except on close inspection, and the leg seems to end with the tibia, on which, of course, the insect walks.

One of the strangest and most unexpected of the uses to which we could imagine a leg as being put is that of an organ of hearing. Yet such seems to be one at least of the functions of the fore-legs in the cricket and some other allied insects. On the outer side of the tibia (Fig. 5)

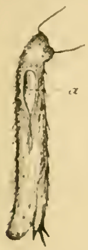


FIG. 5.—Fore-tibia of House Cricket. *a*, auditory organ.

FIG. 6.—Fore-leg of Tortoise-shell Butterfly. *f*, femur; *t*, tibia; *s*, tarsus.

a small oval space may be seen in which the strong armature which covers the rest of the body is reduced to a thin and membranous condition, making thus a sort of window or drumhead. Communicating with this, inside the leg, are the ends of a nerve, and it can hardly be doubted therefore that the whole apparatus constitutes an auditory organ, so that if these legs were amputated, the insect would become deaf. When one remembers that crickets are amongst the noisiest of insects, their incessant chirrup being a most shrill and penetrating sound, it cannot be considered strange that distinct organs of hearing should also be present; the sound-producer implies the sound-perceiver; the two functions are complementary; but still it is remarkable that the fore-leg should have been selected as the most suitable site for this important sense.

Our last type of leg scarcely deserves the name of leg at all, as it is shrunken in size, and does not reach the ground. It is met with in certain butterflies, which, so far as walking is concerned, move about on four legs only instead of the usual six. The Common Tortoiseshell Butterfly will serve very well to illustrate this peculiarity.

Here the fore-legs (Fig. 6) are much shorter than the other two pairs, though composed of the usual parts. Their whole surface is thickly covered with long hairs which project beyond the end of the foot, and thus effectually prevent it from being used to rest upon, and the whole limb has the appearance of a sort of dusting brush. These small brush-like legs lie folded up on the breast, and their hairiness so effectually conceals their form that they are with difficulty distinguished from the general fluffiness by which they are surrounded; hence at first sight the butterfly appears to be really a four-legged insect, and it is only on poking about carefully amongst the hairy mass that the apparently missing pair are discovered.

A NEW ALGOL VARIABLE. +43° 4101.

A STRIKING illustration of the value of the library of glass photographs collected at this Observatory during the past seventeen years has been shown within the last few days. Comet 1902A was discovered by Mr. Brooks on April 14th, and it was found that a photograph had been taken here on April 3rd with the 8-inch Draper telescope, approximately in the direction from which the comet came. An examination of this plate was accordingly made by Mrs. Fleming, superposing it upon another plate of the same region taken with the same instrument on March 7th, 1900. No trace of the comet was found, and in fact the elements now indicate that it was a little beyond the region covered by the photograph. One star, however, in the constellation Lacerta, according to Heis, but in Cygnus according to the Uranometria Nova, appeared faint on the early plate and bright on that taken later. A further examination showed that this object was the north preceding component of +43° 4101. Its position for 1900 is R.A. = 21h. 55·2m., Dec. = +43° 52′. The difference in right ascension of the two components is about 2·0s., the difference in declination 0′·3. A further examination showed that the star was generally bright and constant in light, so that it must be a variable of the Algol type. It is not very distant from the remarkable variable star SS Cygni, which precedes it 16m., and is 14′ south. This last star was discovered at this observatory in 1896, and is ordinarily faint, becoming suddenly bright at intervals which appear to be irregular. Only one other star, U Geminorum, is known to undergo similar changes. The star, SS Cygni, has been carefully studied here, several hundred photographs having been taken of it. It has also been observed visually on several hundred nights both here and elsewhere, but as yet the law regulating its outbursts of light has not been discovered. Again the advantage of the photographic method is indicated, since each plate taken for SS Cygni can be used for studying the new variable, or any others that may be discovered in this part of the sky, as well as if taken for each alone, while of course the visual observations of SS Cygni can be used for no other star. The total number of plates showing the new variable at full brightness is 388, of which 1 was taken in 1889, 10 in 1890, 12 in 1891, 8 in 1892, 9 in 1893, 3 in 1894, 10 in 1895, 37 in 1896, 184 in 1897, 30 in 1898, 37 in 1899, 28 in 1900, 7 in 1901, and 12 in 1902. Besides these, the star appears on 54 photographs taken with the 2·5 inch anastigmat, but they have not been included in the present discussion, since the proximity of the other component in some cases renders it difficult to decide whether the variable is at its full brightness or not. Besides these plates, 19 were found on which the variable, which ordinarily has the magnitude 8·9, was of the magnitude 9·3 or fainter.

At first the period was thought to be 1·498d., but this was found to be an error. The true period appears to be about 31·304d., and the times of minimum are represented by the formula, 2,410,015·05 + 31·304 E. The star retains its full brightness for 28 days, its photographic magnitude at maximum being 8·9. About a day before the minimum it begins to diminish, attaining the magnitude 9·0 at 1·05d. before minimum, 9·5 at 0·94d., 10·0 at 0·84d., 10·5 at 0·71d., 11·0 at 0·58d., and 11·5 at 0·43. The light remains nearly constant for more than half a day, with the minimum magnitude 11·6. The time of increase is more uncertain, but apparently is nearly the same as that of decrease. The period of this Algol star, 31·4 days, is more than three times that of any other as yet discovered, and the duration of minimum, 2 days, is double that of S Cancri, the next in length. The period of S Cancri is 9·5 days, and the duration of minimum 0·9 day. The last minimum of +43° 4101 occurred on April 28th, 1902, at 21h. 33m., G.M.T. The predicted times of the next minima are May 30d., 4h. 51m., June 30d., 12h. 8m., July 31d., 19h. 26m., September 1d., 2h. 44m., and October 2d., 10h. 2m., 1902.

EDWARD C. PICKERING.

Harvard College Observatory,
May 6th, 1902.

ASTRONOMY WITHOUT A TELESCOPE.

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

XV.—NEW STARS.

The appearance of a "new star" has, in all ages, been felt to be an impressive occurrence. The constellation groupings are so permanent in their character, that to see of a sudden some old familiar pattern amongst the stars changed in its features by the sudden appearance of a new member, a star like the other stars and not a planet, for its place undergoes no change—is so at variance with our ordinary experience, that it is no wonder that our forefathers regarded such an event as partaking of the supernatural. In the times before the telescope—indeed we might go further and say in the times before the spectroscope—such an event brought no information with it. It was impressive, it excited curiosity, but it conveyed scarcely any lesson. The spectroscopic examination of "new stars," on the other hand, has been extraordinarily fruitful, though we are very far as yet from being able to fathom the exact meaning of the facts which we have observed. One thing is clear, namely, that bodies appearing so suddenly as "new stars" have always done, and fading away again so quickly, must differ entirely from the great host of permanent stars. And yet we cannot but feel that the changes through which a "new star" may pass in a few weeks, and the order in which those changes succeed each other, may throw much light upon the changes which have marked in the past, or will mark in the future, the life-history of the more stable members of the heavenly host.

It is this thought which makes the watch for "new stars" of such importance. They offer to us a key, which, however imperfect, is the only one which we can hope to find to unlock the secrets of stellar evolution. And that the "new star" may give us the fullest information within its power, it is essential that it be subjected to the scrutiny of the spectroscope whilst its light is still on the increase. The importance therefore of a stringent watch on the heavens does not lie at all in the *éclat* which will justly attach to the observer who is fortunate enough to be the first to detect a stellar outburst, but in the supreme importance that not one of the few short hours during which the star's light is on the upgrade may be unnecessarily wasted.

Such watching is not for the casual star-gazer, nor for the *dilettante* who has never taken the trouble to master the star-groupings and the coming and going of the planets. The planets especially are sad foes to such unqualified aspirants; and just as the "Crab" Nebula, Praesepe, and even the Pleiades, have sent many eager comet-hunters in hot haste to claim a comet medal, so Venus, Mars and Jupiter have inspired hundreds of letters to observatories or to newspapers to draw attention to "the wonderful new star." One of the most amusing instances of the kind was when the discoverer of the pseudo-planet Vulcan announced to the Paris Académie des Sciences his discovery of "a strange object in Leo," which proved to be no other than the planet Saturn.

The first duty, therefore, of the watcher for "new stars," is to work slowly, steadily, and systematically through the constellations till he has made himself thoroughly acquainted with the appearance, brightness, and position of their every member. When he has done this, then night after night it will be his task, whenever the skies are clear enough, to carefully scrutinise all the stars within his view. The labour will be great, but it must be borne in mind that such acquaintance with the heavens and such regular scrutiny of them are necessary for all the varied branches of "Astronomy without a Telescope," so that the watch for "new stars" may well be incidental only to other lines of work. To be the discoverer of a "new star" renders an observer rightly famous, but as the experience of the past fifty or sixty years shows that we cannot hope to record a discovery of the kind more frequently than once in nine years on the average, it is clear that it ought to be made subsidiary to some more fruitful line of research. The systematic eye study of the Milky Way is particularly a form of astronomy which might be combined with it; since it is on the Milky Way, or on its branches, that all the *Novæ* have been found, as the accompanying diagram will show.

The most famous of all "new stars" is, of course, the one which appeared in the constellation Cassiopeia in November, 1572, and which is always associated with the name of Tycho Brahe, since, though he was not actually the first to discover it, he has left us the fullest and most systematic observations of it. It was lost to sight in March, 1574, after having been visible for seventeen months. Thirty years later another "new star" appeared, only less famous than the *Nova* of Cassiopeia. This one was also observed for seventeen months, and is always associated with the name of Kepler, though its actual discoverer was not Kepler himself, but one of his pupils, John Bronowski. Its position was in the right foot of Ophiuchus.

No such brilliant *Novæ* as these have been seen in more recent times, since both stars were reckoned, when first seen, to be brighter than Jupiter; indeed the star of 1572 ranked as equal to Venus when at her greatest brilliancy. The first of those noted in modern times was, like that of 1604, discovered in the constellation Ophiuchus. It was detected by Mr. Hind on April 28th, 1848, and was then increasing in brightness. Four days later it attained its maximum, which only ranked it of the fifth magnitude. The second star of the list was discovered in the globular cluster 80 Messier, which lies between Alpha and Beta Scorpii. The third was detected by Mr. Birmingham at Tuam on May 12th, 1866, when it was recorded as of the second magnitude. It may be doubted, however, whether this star is quite of the same order as the others. It had been observed several years previously as of magnitude 9½, and it still remains visible, being now classed as a variable under the name T Coronæ. Still its outburst must have been very sudden, for Dr. Julius Schmidt, whose acquaintance with the heavens was of the very closest, declared that about two and a half hours previous to Mr. Birmingham's discovery, he had the constellation of the Northern Crown under his observation, but had noted nothing unusual. The next discovery was to fall to his own lot. On November 24th, 1876, he found a third magnitude star had appeared in the constellation Cygnus. This star rapidly faded away, and was only of the fifth magnitude on November 30th. Its spectroscopic history was of intense interest, for, by September, 1877, the light coming from the star was almost entirely monochromatic, and corresponded with that which would be given by a planetary nebula.

The next "new star," discovered independently by a considerable number of observers in August, 1885, was actually involved in a nebula, the great nebula of Andromeda, and was close to the nucleus. This was wholly a telescopic *Nova*, and since that time several other telescopic *Novæ* have been discovered by means of the photographic charts which have been made at the Harvard College Observatory, or at its southern annexe at Arequipa, Peru. But two *Novæ* have been detected besides these, both of which were naked-eye objects, and the history of their discovery is in the highest degree encouraging and instructive for the "astronomer without a telescope." On February 1st, 1892, an anonymous post-card was received by Dr. Copeland at the Royal Observatory, Edinburgh, with the following announcement:—

"Nova in Auriga. In Milky Way, about two degrees south of χ Aurigæ, preceding 26 Aurigæ. Fifth magnitude, slightly brighter than χ."

That night the star was examined by means of an eyepiece prism at the Edinburgh Observatory, and its spectrum was seen to contain many vivid bright lines, which at once marked it as a "new star" of spectroscopic interest, not inferior to the one which had made so great a sensation in 1866. And the anticipations which that first glance gave were much more than fulfilled. Indeed, Nova Aurigæ opened an entirely new chapter in the spectroscopic study of stars of its class; but such study is apart from our present purpose, which cannot be better fulfilled than by quoting the account given by the discoverer, the Rev. Thomas D. Anderson, in a letter which appeared in *Nature*, February 18th, 1892.

"Prof. Copeland has suggested to me that as I am the writer of the anonymous post-card mentioned by you a fortnight ago (p. 325), I should tell your readers what I know about the Nova.

"It was visible as a star of the fifth magnitude certainly for two or three days, very probably even for a week, before Prof. Copeland received my post-card. I am almost certain that at 2 o'clock on the morning of Sunday, the 24th ult., I saw a fifth magnitude star making a very large obtuse angle with β Tauri and χ Aurigæ, and I am positive that I saw it at least twice subsequently during that night. Unfortunately, on each occasion I mistook it for 26 Aurigæ, merely remarking to myself that 26 was a much brighter star than I used to think it. It was only on the morning of Sunday, the 31st ult., that I satisfied myself that it was a strange body. On each occasion of my seeing it, it was brighter than χ. How long before the 24th ult. it was visible to the naked eye I cannot tell, as it was many months since I had looked minutely at that region of the heavens.

"You might also allow me to state, for the benefit of your readers, that my case is one that can afford encouragement to even the humblest of amateurs. My knowledge of the technicalities of astronomy, unfortunately, is of the most meagre description; all the means at my disposal on the morning of the 31st ult., when I made sure that a strange body was present in the sky, were Klein's 'Star Atlas' and a small pocket telescope which magnifies ten times."

An examination which Prof. Pickering had made of photographs which had been taken at the Harvard College Observatory of the region of the Nova, showed "that the star was fainter than the 11th magnitude on November 2nd, 1891, than the 6th magnitude on December 1st, and that it was increasing rapidly on December 10th." It would seem to have attained a maximum about December 20th, when its magnitude was 4·4. It then decreased slightly for about a month, fading to somewhat below the 5th magnitude. When Dr. Anderson detected it, it was again on the upgrade, and it seems to have reached its maximum about February 3rd, after which it declined. The star therefore had been visible to the naked eye for fully six weeks before Dr. Anderson's discovery, a time when it was evidently passing through the most interesting and important changes. But for his zeal in studying the heavens, it would without doubt have escaped notice altogether, and the spectroscopic revelations which it yielded would have been wholly lost.

This success naturally stirred Dr. Anderson up to making the search for "new stars" his serious business, as he narrates in a most interesting letter addressed to the *Observatory* for March, 1902. He writes:—

"I need hardly say that before the advent of Nova Aurigæ my astronomisings were fruitless—fruitless, that is to say, so far as the rest of humanity was concerned—but far from being fruitless as regarded myself, for there was for me, at least, a certain joyful calm when, after a long evening spent in writing sermons or in other work, I threw up the window, and taking out my little pocket telescope, surveyed the never palling glory of the midnight sky. But after the appearance of Nova Aurigæ the thought occurred to me that perhaps after all 'new stars' might not be such rare phenomena as had up to that time been supposed. The correctness of that surmise has been proved by Mrs. Fleming's discovery since then of no fewer than five of these objects on the Harvard College

Northern Hemisphere. Southern Hemisphere.

Distribution of New Stars relative to the Milky Way.

(The Novæ discovered by Mrs. Fleming on the Harvard Photographic Plates are distinguished by the letter *F* above the date.)

photographs, although it is certainly strange that all these *Novæ* should have appeared in the southern hemisphere. I therefore resolved to commence a search for new stars."

Dr. Anderson's purpose was not confined to stars visible to the naked eye, but extended to all stars included in the great work of Argelander and Schönfeld. This necessitated his making charts for himself for the regions south of +40°, a work which meant the plotting down from their catalogue places of more than 70,000 stars. The instruments with which he worked were a large binocular and two refractors, one of $2\frac{1}{4}$ inches, the other of 3 inches aperture, and which respectively enabled him to see stars of the 10th and 11th magnitude. To continue his own account:—

"Thus armed I began to hunt for 'new stars.' I worked with might and main, never going to rest as long as the sky remained clear, and often rising in the night to see if the clouds had passed away, and if they had, hurrying downstairs to begin work either with the binocular or with the telescope. The chief obstacle that I have to contend with in such work is that the only windows in this house from which I can thoroughly examine the heavens, face the north-west. Not only is my field of labour thereby very greatly circumscribed, my telescope being only able to command that part of the heavens which extends from the Equator to +70°, but the discomfort is frequently not inconsiderable, as the northerly and north-westerly winds, which so often bring with them transparent and unclouded skies, are in winter and early spring far from being balmy, and can make themselves felt even when the window shutters are partially closed.

"At first my search was mainly for *Novæ*, and was prosecuted by means of my binocular. . . . When I came to see that hunting for *Novæ* was not attended by the success which I had anticipated, I began, without entirely abandoning such work, to make a systematic search for variable stars. For this I used my $2\frac{1}{4}$-inch telescope, comparing what it showed me with the representation of the heavens contained in the B.D. charts. . . . . I was always glad if after three or four months of searching, during which I might have examined perhaps 20,000 stars and suspected fifty or sixty of variability, I was able at last to come across one whose brightness changed.

"I found Nova Persei, I need hardly say, without either binocular or telescope when I was casting a casual glance round the heavens."

It was then no mere happy chance that the Council of the Royal Astronomical Society were honouring, but the most persistent and strenuous work, when at the annual meeting of February, 1902, they conferred upon Dr. Anderson the Jackson-Gwilt Medal. The words of the President to him, when presenting the medal, put the case briefly and clearly.

"Nova Aurigæ was discovered by you on February 1st, 1892, when of the 4th magnitude, and but for your discovery it might have escaped observation. Nova Persei was discovered on February 22nd of last year at 2.40 a.m., when of 2·7 magnitude and low down in the sky. This early discovery of yours made it possible for Pickering to obtain its spectrum before its maximum was reached. It is no small matter to have discovered one of these *Novæ*, but it is a veritable *tour de force*, such as *à priori* would have seemed impossible to have discovered both, and I am delighted that we have the opportunity to congratulate you on your success and to do honour to your astronomical zeal and intimate knowledge of the sky."

One point with regard to the discovery of Nova Persei deserves further mention, namely that Dr. Anderson's discovery was made almost simultaneously with the outburst, for photographic records show that so late as February 19th the star must have been fainter than the 11th magnitude. It had probably only entered the ranks of stars visible to the naked eye a very few hours when Dr. Anderson remarked it. But it is gratifying to remark that whilst, but for Dr. Anderson, Nova Aurigæ would have passed entirely without detection, the closer watch which is now kept upon the sky resulted in several entirely independent discoveries of Nova Persei. Herr F. Grimmler discovered it the same morning at Erlangen; Captain P. B. Molesworth at Trincomali was not quite twelve hours after Dr. Anderson, and four hours later still Mr. Ivo Carr Gregg, at St. Leonards, had also detected it, and communicating his observation to Col. E. E. Markwick, the Director of the Variable Star Section of the British Astronomical Association, the other members of that Section were made aware of the event before the news of Dr. Anderson's discovery had reached them through the ordinary channels of information.

DISTANT WORLDS.

I.—A REVIEW OF SOME RECENT STUDIES IN STELLAR DISTRIBUTION.

By C. Easton.

Everything is relative. This maxim applies to things celestial as well as to things terrestrial. The planet Mars is a distant world, but the distance which separates us from it is insignificant when compared with the abyss which yawns between the sun and the nearest stars: Alpha Centauri, Sirius, Arcturus, which are distant 3, 9, 20 *light-years*. Yet these worlds touch upon us, so to speak, for the confines of our stellar system, of the Galactic system (and perhaps there exist other galaxies in the depths of space), are situated, according to Seeliger, at a distance a thousand-fold greater, at a distance so stupendous that I cannot resist the temptation to express it in kilometres:—

100,000,000,000,000,000.

There is no need for me to insist on the point that this value is not a precise one. Nevertheless, it is based on serious calculations and deductions, and it can at least give some idea of the *order* of distances with which we have to deal when we undertake the study of the Milky Way. As for the number of stars contained in the system, it is probably not less than 60 millions, and is perhaps still greater; so that the total number of stars visible by the naked eye—about 6000—forms only a negligeable quantity of this prodigious sum, and even the 906,000 stars above the 9th or 10th magnitude, enrolled in the "Durchmusterungs" of Argelander and Schoenfeld, of Gill and Kapteyn, constitute but an insignificant fraction.

I have referred to distances and numbers as prodigious as these at the beginning of the article, since they may serve as an excuse for not being yet able to present striking and definite results, when I pass in review what astronomers have found out about the structure of the visible universe in the last four or five years, and both life and progress are rapid in these days. Astronomy, as an exact science, is still young; it cannot venture far from its homestead, the earth, without tottering steps, and the objects which we study here are all near our horizon. How comparatively easy would these researches become if we could transport ourselves for a moment outside the Milky Way, near one of the poles of our stellar system. But the Milky Way surrounds us on all sides, and we are somewhat in the position of a stranger who finds himself suddenly planted on London Bridge, and who tries to study the configuration of the metropolis without being able to climb a tower. He would find some indications to guide him in the trend of the river, the directions of some principal streets, and in the crowd which surrounds him, but for the rest he must trust to the guidance of indirect reasonings. The mind of man is in much the same case when it tries to probe "*Ces fourmilières de l'abîme*," as Victor Hugo calls the Milky Way.

Nevertheless, from what follows, I hope we shall see that our knowledge of the structure of the universe has made real and substantial progress since the epoch—1898—when

Professor Seeliger, of Munich, set himself to again try the "statistical method," that which concerns itself with the apparent distribution of the stars in order to infer from this their real distribution in space.* Seeliger utilised for this the enumeration which he himself made of the stars observed by Argelander, Krueger and Schoenfeld (as far as magnitude 9·5 or 10), beside a research of Celoria, present Director of the Milan Observatory, on fainter stars, then of the gauges of the two Herschels, and of a work which the author of this paper had published some years before on the distribution of stars of different magnitudes in a portion of the Milky Way. There is no need for me to dwell at length on these matters (*see* Knowledge for August, 1895). I will confine myself to giving as succinctly as possible the conclusions to which the German astronomer has arrived in his researches.

We know that the stars, taken as a whole, become more numerous in proportion as we approach the Milky Way, from which it follows that the phenomenon of the Galaxy is intimately connected with the distribution of the other stars. Seeliger first shows that this progressive increase towards the plane of the Milky Way is not due to the systematic errors in the brightness of stars, which have been established in the Durchmusterung of Argelander. He also shows that this progression is not regular, that the stars of very feeble brightness—fainter than magnitude 11 or 11·5—are distributed quite differently from the more brilliant stars; we find these faint stars in only relatively small numbers near the poles of the Milky Way; within the Galactic zone, on the contrary, they are exceedingly numerous, and the same appears to hold good for stars of a still feebler brightness, such as Herschel's telescope scarcely sufficed to show. All those stars, which appear to us as minute light points, are, for the most part, really confined to the Milky Way. Thus the stellar universe does not seem to be indefinitely extended in the Galactic plane. We can imagine it to be, according to these researches, of a fairly thick lens shape, filled with stars which are much more densely congregated near the edges than near the centre of the lens. Our sun is not precisely at the centre, but neither is it very far removed from it. The southern zone of the Milky Way is probably less rich in stars than the northern zone. These conclusions are not new, but they rest on a large amount of material, and on rigid mathematical development. Seeliger estimates the distance between our sun and the internal border of the zone of stellar condensation (that is to say the Milky Way properly so called) as 500 times the distance of Sirius—the annual parallax of this star is about 0″·37, which places it at 8·8 light-years, or 560,000 semi-diameters of the orbit of the earth—the external border as 1100 times the distance of Sirius. There lie the limits of the stellar system to which the sun belongs. This system reckons probably (according to Seeliger) from 27 to 41 millions of stars down to the magnitude just visible in Herschel's telescope, a magnitude that we cannot fix, but which we can estimate to be of the 13th or 14th.

As for determining more exactly the relative positions of the most crowded regions on the borders of the stellar system—they must not be confused with clusters properly so called, agglomerations of a more intimate nature—Professor Seeliger makes no effort to do so. "It may be a rather vague expression," he says, "to speak of an *annular Milky Way*, but these words indicate fairly well the general distribution of the stars, but nothing hinders us from esteeming certain portions of the Milky Way to be nearer to us, and others more remote, than the average stars of magnitude 9·5 (Argelander), whose distribution in certain parts of the zone presents a remarkable analogy to the situation of the brilliant and dark spots of the Milky Way."

Seeliger does not admit that an appreciable extinction of light can be made sensible in our stellar system. Such an extinction, however, might easily prevent our perceiving other galaxies besides our own, whose existence Seeliger does not presume to deny, although we have no undoubted direct indication of it.

A Russian astronomer, W. Stratonoff, of the Observatory of Tashkent, in Central Asia, has taken a different method of placing in evidence the apparent distribution of the stars.* He follows the cartographic method in continuation of the work of the Italian astronomer, Giovanni Schiaparelli. It was Richard Proctor who especially demonstrated the use of charting in astronomy, and who drew from it important conclusions. Schiaparelli and Stratonoff not only insert on their charts the stars themselves, but for each order of brightness (magnitude 0—6 or 6·5, 6·6—7, 7·1—7·5, &c.) the relative densities of the stars contained in Argelander's catalogue. Then they join by lines portions of equal density, and they obtain charts resembling topographic charts on the earth where the contour-lines mark out the greater or less elevation of the surface. The portions of the sky comprised between these lines are therefore regions where the stellar density is very nearly the same, and for greater clearness these regions are tinted in colours of a depth the more pronounced in proportion as the density is greater; so that the region of the deepest tint has, for a certain stellar class, an extreme density, whilst, on the other hand, regions where the densities are not up to the mean density are left quite white.

It goes without saying that such charts are very useful for showing at a glance where the stars of a certain magnitude are more or less strongly condensed, and that a comparison of the charts will teach us whether there is anything systematic in the manner in which stars are condensed in certain regions—as, for example, in the Galactic zone, according as we take into consideration stars of a feebler brightness. Schiaparelli, in a work published in 1889, took into consideration both hemispheres, but he did not go below the magnitude 6·5—that is to say, almost the limit of stars visible to the naked eye. Stratonoff goes much farther, down to 9·5th magnitude of Argelander, but, on the other hand, he has had to confine himself to the northern heavens. The results of his research are not the less interesting.

We will enter now into the details of the stellar distribution of which Seeliger alone has studied the general features. An inspection of Stratonoff's charts shows us at once that the stars do not cluster towards the entire zone of the Milky Way continuous and uninterrupted as we see it with the naked eye, but principally *towards certain parts* in this bright band. It is as if the stars were attracted particularly towards this region of the Galaxy, and were repelled from that region. For the brilliant stars these places of condensation in the Milky Way are not constant; thus the chart of the stars of the class 0—6·5 show other maxima than those of the class 6·6—7·0; but soon—after about passing the 8th magnitude—the condensation of stars of an intermediate brilliancy preserves in general the same configuration up to the limit of Argelander's catalogue. We find for stars between the 8th and 10th magnitude, maxima of condensation in Auriga and Monoceros, and a minimum in

* Seeliger: "Betrachtungen ueber die räumliche Vertheilung der Fixsterne." München. 1898.

* W. Stratonoff: Public. de l'Obs. de Tashkent, II.; "Etudes sur la Structure de l'Univers." I. 1900.

Perseus, and pre-eminently a maximum very large and pronounced whose centre falls in Cygnus and which spreads over Cassiopeia and Aquila. Outside the Milky Way the density of Argelander stars, taken as a whole, does not attain to any maximum.

It is worthy of notice that so long as it concerns the relatively bright stars—by comparison with the minute stars which especially produce the optical phenomenon of the Milky Way—the naked eye perceives nothing of the condensations that I have indicated here. The stars visible to the naked eye group themselves especially round Orion and Argo in a zone which makes an angle of 20 degrees with the Milky Way—"the belt of bright stars" recognised and described by Sir John Herschel.

In a second article I will compare the results obtained by Seeliger and Stratonoff, with researches of another order, to draw from them some conclusions on the subject which is now occupying us.

THE "AMERICA" NEBULA IN CYGNUS.

By Dr. Max Wolf.

Herschel records an exceedingly faint and very extended nebulosity in this place. On the 12th of December, 1890, working with a 5-inch Kranz photographic doublet, I discovered here a very fine and interesting nebula of enormous dimensions, and very bright photographically. As the outlines of the nebula almost exactly resembled those of North America on the map, I called it the "America" nebula. I published a picture of it in Knowledge for July, 1892. Last year I succeeded in obtaining a photograph of it with my two 16-inch Brashear portrait lenses. The photograph of the two which is otherwise the better has a defect near the middle of the plate; the accompanying reproduction is therefore from the other one. Although it is from the worse negative of the two, it is a very interesting picture, and shows very well the unrivalled beauty of the "finest nebula of the sky." The extent of the nebula from north to south is in all more than three degrees. The bright nebulous star on the right hand (the west) is the star ξ Cygni, and many interesting arms and wings of nebulosity radiate from it.

The centre of the "America" nebula has the co-ordinates:—

R.A. = 20h. 54m. Dec. = 43° 45′ (1855·0).

The plate was by Schleussner; it was exposed for four and three-quarter hours in all on the evenings of July 12th and 13th, 1901. Scale one degree equals about eight centimetres.

Heidelburg.

THE USE OF HAND TELESCOPES IN ASTRONOMY.

By Cecil Jackson.

IV.—THE STARS.

I will now describe a few objects within the reach of hand telescopes not exceeding two inches in aperture. One of the most striking double stars visible in a 1½ or 2-inch telescope is Mizar (denoted in star-maps by the Greek letter ζ), in Charles's Wain, or the Great Bear.

Fig. 9 shows the position of Mizar in Charles's Wain. There is also another beautiful double star in the adjoining constellation of Canes Venatici. It is marked Cor Caroli in Fig. 9. One of the stars of this double is a beautiful blue, or blue-green. It is a notable fact that if one of the stars of a double is blue the star of this colour is the smaller of the two.

Fig. 10 shows Mizar, as seen with my 1⅝-inch telescope

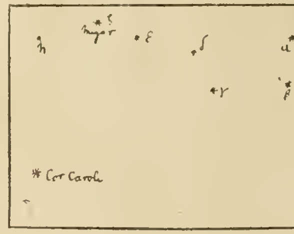


Fig. 9.

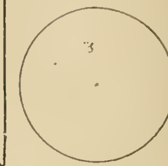


Fig. 10.

on Sept. 3, 1892. An astronomical eye-piece of fairly low power was used on the instrument. A power of thirty or thirty-five will readily divide this double star.

Fig. 11 shows the chief stars in Orion, as well as the position of the Great Nebula. This constellation is very easily recognised in the southern sky during the winter months. The Nebula can be seen with a pocket telescope on a dark night.

Fig. 12 gives some idea of the Orion Nebula, as seen in my 1⅝-inch telescope with its own terrestrial eye-piece set to magnify 25 diameters. This sketch was

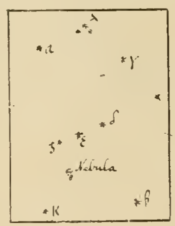


Fig. 11.

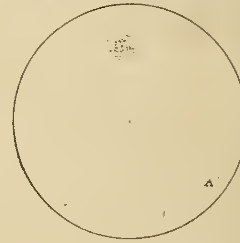


Fig. 12.

made at about 5h. 55m. p.m., Jan. 17, 1900. There are many stars near the Nebula, some of which are shown in this sketch. The pair A is worthy of notice.

The group λ is remarkable as seen in the telescope, being then seen to be a triangle composed of three stars. There are also many smaller stars visible in the field of view. The star Betelgeuze (α) is noticeable as

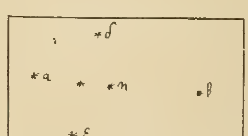


Fig. 13.

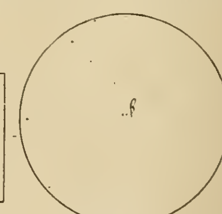


Fig. 14.

being a reddish star, while the star Rigel (β) is a brilliant white.

Another double star visible in a small telescope is β Cygni. Its position in the Cross in the constellation

THE "AMERICA" NEBULA IN CYGNUS.

of the Swan is shown in Fig. 13. The Cross in the Swan is to be seen about overhead when darkness is coming on during the months of July, August, and September.

Fig. 14 shows β Cygni as seen by me at about 8h. 46m. p.m., Aug. 21, 1895. The companion-star of β is a lovely blue colour. For the purpose of observing star-groups it is sometimes desirable to use the terrestrial

Fig. 15.

eye-piece without the two lenses nearest to the object glass; that is to say, without the erecting lenses. The two lenses nearest the eye-end are to be left in their places. After replacing the eye-piece when the first-mentioned lenses have been removed, the draw-tubes of the telescope will have to be pushed in much further than before in order to get the telescope into focus. By removing the two lenses a large field of view is obtained, but the magnifying power is much lowered, so this method should not be resorted to when observing planets.

Fig. 15—Cassiopeia's Chair, Chief stars in Andromeda, Great cluster in Perseus. Cassiopeia's Chair is on one side of the Pole-star; Charles's Wain on the other. There are very fine fields of stars to be seen in this region in the Milky Way. The cluster in Perseus is a fine sight, especially with a low power on a 1½ or 2-inch telescope.

Fig. 15 shows the chief stars of Andromeda as situated

Fig. 16.

with regard to Cassiopeia's Chair. The Nebula will be found by moving the telescope backwards and forwards horizontally in the neighbourhood of the star ν. At the end of each horizontal sweep of the instrument, elevate it a little, and then move it back again, only over a higher strip of sky parallel to, and partly overlapping the first strip. Repeat this process till the Nebula comes into view. You must, of course, make sure of beginning your search *below* the position of the Nebula. By making the strips of sky overlap the chance of missing the Nebula between the sweeps of the telescope is avoided. The Nebula itself is oval, brightest at the centre. This is a sketch of the Nebula made by me at about 5h. 35m. p.m., Saturday, Nov. 16, 1895. My 1⅝-inch telescope minus the two lenses nearest the object glass was used in making this sketch. The Nebula appears to consist of concentric rings as seen in a photograph of it taken by Dr. Isaac Roberts in Dec., 1888.

The star γ Andromedæ is a double star, the companion being sea-green. The companion itself was found to be double by Otto Struve in the year 1842.

In bringing these notes to an end, I hope I have given sufficient information to induce some to begin to study the wonders of the heavens, even though the instruments at their command may be of so humble a description as a mere hand telescope.

Letters.

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

THE VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Before we can accept as facts such prodigies of vision as the detection of the crescent of Venus, or of the elongated figure of Saturn, with the unaided eye, we ought to be able to exclude one source of error which is very likely to vitiate such observations, viz., the regular astigmatism of the eye which is present in almost all cases.

The very name of this optical defect serves to indicate the way in which it may lead to mistakes. It was coined by Whewell in order to emphasize the fact that rays of light proceeding from a point do not again unite in a point after passing through a refractive system of the particular kind called astigmatic.

In the human eye the cause of astigmatism is the asymmetry of the cornea, and the direction in which the elongation of a point into a line will take place will depend upon the direction in which the planes of greatest and least refractive power are situated. It is most common to find that the cornea is more strongly curved in the vertical direction, and less strongly in the horizontal, but the rule is not invariable.

If then anyone thinks that he can detect any "elongation" of Venus or of Saturn with the unaided eye, he ought to check his observation, before rushing into print, in the following way, repeating the observation with each eye separately. Let him notice the exact direction in which the elongation is seen. Then, keeping his eye on the star, let him bend his head gradually down toward one side, and let him notice carefully whether the direction of the apparent elongation changes as he does so. When the head is quite down on one side the positions of the two planes of greatest and least refraction respectively will have changed places, since in regular astigmatism they are at right angles to one another in the eye. Accordingly the direction in which the star appears lengthened will be now seen to be at right angles to that of its original lengthening if the elongation is due to ocular astigmatism, and will not be affected by this change in the position of the head if it is not due to that cause.

R. J. RYLE, M.D.

15, German Place, Brighton.

[Mr. E. Sillence (Romsey) writes to say: "I have no doubt that twice in my life I have seen the crescent of Venus with my naked eye." Mr. Sillence believes that the occasion of these observations was June, 1897, the planet being observed in the bright dawn before sunrise, "so that the usual glare of the planet was gone." The claim that the crescent of Venus has been seen with the naked eye has been made several times, no doubt in the completest good faith. But since—as Dr. Ryle is without doubt right in suggesting—the impression has often been due to astigmatism of the eye, and as in other cases imagination may have been at work, it is essential that before any such claims can be accepted as a scientific fact, the observer should have not only been careful to put on record the exact time and conditions of his observation, but should have been able to show by many experiments, in which the influences of astigmatism and imagination were excluded, that he really possessed the ocular ability necessary to perform so astonishing a feat.—E. WALTER MAUNDER.]

THE DATE OF STONEHENGE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In the May number of KNOWLEDGE Mr. Maunder states that the dates which different careful observers have deduced for the erection of Stonehenge extend over a period of more than 2000 years. While this statement is true if all the derived dates are included, I think it may be worth while to point out that only two of the attempts to determine the date astronomically have been made with a proper grasp of the conditions of the problem and with adequate data—one by Prof. Flinders Petrie in 1881, and the other by Sir Norman Lockyer and Mr. Penrose last year. Other determinations may be left out of consideration, because usually no allowance has been made for refraction and elevation of the horizon, both of which are, of course, important factors in modifying the apparent direction of sunrise. Prof. Petrie's observations were made differentially with evident care, but the date 730 A.D. which he derived cannot be accepted, for the simple reason that in the calculation on which the result is based the variation of the obliquity of the ecliptic was, by a curious slip, applied in the wrong direction. The determination by Sir Norman Lockyer and Mr. Penrose thus practically stands alone, and the date 1680 ± 200 B.C. which they deduced is in as close agreement as can be expected with the 2000 B.C. which Dr. Gowland has since derived from a consideration of the objects found in the excavations.

A. FOWLER.

THE SUN PILLAR OF MARCH 6.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—There is one point with regard to the sun pillar which was seen on March 6th which I have seen no notice of anywhere; and so I venture to call your attention to it—perhaps without occasion—viz., the large portion of the country over which it was visible. I cut out letters in the *Times* showing it was visible at Falmouth, Salisbury, and Cranleigh in Surrey. Also at Woking and Guildford and Crawley, Royston, Oxford, Horsham, Hindhead, Botley, Bournemouth, and Braunton (North Devon). These are all below the 52nd parallel. I can, however, add about another degree of northing to that, for I saw it very plainly from here. This means that it was visible over about half of England at any rate. Is it then something cosmical as the sun shining upon a ring of innumerable small bodies in space, and the light being reflected to us; or is it due to a condition of atmosphere extending over hundreds of square miles, and causing each one of us to see his own sun pillar, as he sees his own rainbow?

Pool Quay, Welshpool. R. J. ROBERTS.

[In reply to Mr. Roberts and to other correspondents who have asked for an explanation of the cause of a sun pillar, there can be no doubt that his second alternative is the correct one. A sun pillar is due, not to any cosmical collection of particles outside our own atmosphere, nor to refraction, but to reflection, the reflection that is to say of the sun from the under surfaces of ice films floating horizontally in still air. The phenomenon therefore bears a close analogy to the very familiar one of the "track" of light which we see upon still water when we are looking across it towards a low sun. As each several observer sees his own "track," so each observer sees his own sun pillar. The two phenomena are shown together in the sketch of the sun pillar of January 30th, 1895, drawn by the Rev. Samuel Barber for KNOWLEDGE, June, 1895.—E. WALTER MAUNDER].

Conducted by W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U.

PENGUIN FOOTPRINTS.—At the meeting of the British Ornithologists' Club, held on the 21st of May, Dr. R. Bowdler Sharpe, LL.D., exhibited some remarkable specimens of rocks brought from the Falkland Islands by Mr. Rupert Vallentin. These rocks formed the track from the landing place to the breeding ground of the Rock-hopper Penguin, *Catarrhactes chrysocome*, and consequently had been constantly traversed by thousands of birds for countless generations. As a result the surface of the rock had become marked by deep "scores" made by the claws of the birds as they scrambled over its surface. Many larger slabs of rock, showing still better traces of this restless traffic, were taken, but were lost through shipwreck on the voyage home.

THE LIFE-HISTORY OF THE PENGUIN.—An extremely interesting and valuable account of the life-history of the Emperor and Adelia Penguins will be found in the Report of the Southern Cross Collections made during Sir George Newnes' Antarctic Expedition in 1898. Some of the most interesting of these notes possess a peculiarly mournful interest, having been made by the unfortunate naturalist Nicolai Hansen, who died during the expedition. No less interesting are the notes of Mr. Bernacchi. "By far the the largest Penguin rookery seen during the expedition," he writes, "was that of the Adelia Penguin at the foot of

Mount Terror. This rookery was occupied by millions of Penguins. . . . The brown discoloration caused by these birds can be seen some miles off." The nesting place and the eggs of the Emperor Penguin were sought for in vain. It is to be hoped these may at last be brought to light by the "Discovery" expedition now in progress.

Condor laying in Confinement.—The *Zoologist* for May records an instance of a Condor (*Sarcorhamphus gryphus*) which laid an egg on April 10th, at the Natural History Museum, Newcastle-on-Tyne. The bird was brought from the Chilian Andes as a nestling sixteen years ago.

Great Auk's Egg.—An unusually fine specimen of the Great Auk's egg was disposed of at Messrs. Stevens' rooms on May 15th. It realised 290 guineas—only a little below the record price—and has, we believe, passed into the hands of a private collector.

Moulting the Bill in the Wall Creeper.—The *Field* of May 31st draws attention to a tradition to the effect that the Wall Creeper (*Tichodroma muraria*) moults the distal half of the bill in the autumn. There seems to be some evidence to the truth of this, but as yet corroboration is needed. Ornithologists living in London would do well to keep the specimen lately added to the Zoological Society's collection under careful observation during July and August.

All contributions to the column, either in the way of notes or photographs, should be forwarded to W. P. Pycraft, *at the Natural History Museum, Cromwell Road, London, S.W.*

Notices of Books.

"Selection of Subject in Pictorial Photography." By W. E. Tindall, R.B.A. (Iliffe & Sons.)—This book concerns a branch of photography little heeded by the majority of those multitudes who possess cameras. The walls of two photographic exhibitions are covered annually with examples of well-produced photographs, but among these it is rare to find anything that shows substantial artistic training. This is to be deplored, since fleeting forms of beauty can be seized by the camera in a way denied to the painter—bewildered by rapidly changing expression. And more, for Nature not infrequently casts a picture, totally harmonious, faultlessly composed, and which is sometimes as pleasing in monochrome reproduction as in the doubtful hues imposed by some artists. Mr. Tindall has endeavoured in the book before us to supply this artistic knowledge by illustrating certain laws of composition. His effort scarcely can be called happy. The illustrations, chosen from his own sketches, frequently rely on a mere effect of light for their merit rather than on those subtle and reposeful lines which render the works of a practised artist things of beauty. Plates 3, 7, and 10 are instances of this. Again, to offer a photographer a sketch for his tuition, is to ignore the distinction between the use of a brush and a camera, and this fundamental error renders much of the book valueless. For a beginner, however, those parts of the book which deal with elementary rules of composition, with faults of posture in portraits, and with correct distances to be maintained in figure studies, will be useful. We can further recommend the aspiring photographer steadily to contemplate the title of this book in the hope that by this means a faint impulse in the direction of taking time before the reckless exposure of a plate may be given him.

"The Principles of Inorganic Chemistry." By Wilhelm Ostwald. Translated by A. Findlay, M.A., B.SC., PH.D. Pp. xxvii., 785. (Macmillan.) Illustrated. 18s. net.—There are dozens of elementary text books of chemistry, but they can mostly be arranged in two classes, one of which comprises descriptive books which commence by defining elements and compounds, and then pass to the consideration of non-metals and metals in various orders, while the other follows the more reasonable plan of beginning with the study of common substances and chemical changes and making the results obtained suggest conclusions. The latter is the more scientific method, and is the one now adopted in many schools. Professor Ostwald's work belongs to neither of these categories, but stands practically by itself as an authoritative statement of the position of chemical science and philosophy, so far as inorganic substances are concerned. In its pages the methods and results of inorganic chemistry are surveyed in the light of modern theory; so that the book provides the student with a view of the essential facts and interpretations of chemistry as seen from the position of the greatest living exponent of the science. A notable characteristic of the book is the plan of treatment. Theory is made subservient to practical work, and is only introduced when the results described are sufficient to justify theoretical conclusions. Such subjects as molecular weight, or molar weight as Prof. Ostwald prefers to style it, valency, catalysis, and the phase-rule are dealt with in connection with various elements and compounds, according as the appropriate opportunity occurs for considering them. So it is throughout the book: in fact, not until the last chapter are combining weights and the periodic system discussed. Of course the ionic aspects of chemistry receive particular attention, and no student of the science can now afford to neglect them, for the days of chemical atoms and molecules are numbered. The book is one which every teacher and adult student of chemistry should consult, and for this purpose it ought to be added to every public and college library. The illustrations are line drawings, and some of them are quite out of keeping with the general character of the book. Thus no one who reads the book is likely to need the sketches of the measuring flask and jar on page 188, or those of Bunsen burners on page 409. Far better figures are known to every child who learns chemistry nowadays.

"The Journal of the Anthropological Institute," July to December, 1901. Pp. 161-315. "Man," Nos. 77-153. (London: Anthropological Institute.) 10s. net.—There are thirteen papers in the journal under notice, several of them of great value. In addition, we have a number of original articles and notes in the pages of *Man* bound up with the journal. In the United States or Germany, such contributions to knowledge would be published at the expense of the State, but in England the cost has to be borne by societies or individuals, and the only return is the gratitude of students of anthropology. One of the papers, by the Rev. J. A. Crump, deals with trephining in the South Seas. The natives of some of the South Sea Islands undergo the grave operation of trephining for fractures of the skull, insanity, epilepsy, and even for headache. Though the cavity is cut in the skull with a piece of shell or flake of flint, many of the patients recover. A number of skulls were found in Peru some years ago having holes in them which had evidently been made during life; and Mr. Crump's observations show that primitive men of the present time perform operations like those of which the Peruvian skulls give evidence. Another very interesting paper is by Dr. C. Hose and Mr. W. McDougall on the relations between men and animals in Sarawak. Many of the superstitions described read like stories from a book of fairy tales. Dr. W. H. R. Rivers describes observations made by him in Egypt, and indicating that the Egyptian peasant, like some other peoples, have no name for blue in their vocabulary. Prof. Flinders Petrie shows by pictures from various Egyptian monuments that several distinct types of face can be distinguished, representative of different races. Among the remaining papers are an account, with illustrations, of Irish copper celts, by Mr. G. Coffey, and an illustrated paper on the Lengua Indians of the Paraguayan Chaco. There are many other articles and notes, all of them of interest to students of human races and customs.

"The Summer Birds of Flathead Lake." By P. M. Silloway. (University of Montana. 1901.) This interesting paper contains some observations on the nidification of the birds recorded, and is illustrated by sixteen plates representing nests and eggs, some of which are admirably reproduced.

"Regeneration." By Prof. T. H. Morgan, PH.D. Pp. xii., 316. (Macmillan.) 12s. 6d. net. Illustrated.—Biological science is enriched by this profoundly interesting book. There has been so much speculation in connection with organic evolution during the past ten years that a work like Prof. Morgan's, recording results of experiments and observations upon the regeneration of parts of organisms, is as a breeze to a jaded spirit. It has long been known that when certain organisms, such as hydras, are cut in two, each part produces a new individual. An earthworm cut in two can produce two new worms; tadpoles can regenerate their tails; so can lizards and salamanders; shrimps, lobsters, crayfish, crabs, and hermit-crabs can grow their walking legs if they lose their old ones; the beaks of birds will regenerate; and even in mammals some of the internal organs have extensive powers of regeneration. These remarkable instances show the kind of material with which Prof. Morgan deals; and in the accumulation of it, he and his pupils take a foremost place. Everything relating to regeneration, whether in egg, embryo, or adult, is of significance in connection with theories of evolution; and it is only by the accumulation of knowledge of the phenomena that accurate views of the course of development can be understood. We cannot pretend to show here that this is the case, or to describe the many investigations recorded in the volume under notice, but the following conclusion referring to regenerative changes which are for the good of the organism must be regarded as a statement of the present position of the discussion of the subject:—"The phenomena of regeneration are not processes that have been built up by the accumulation of small advances in a useful direction; they cannot be accounted for by the survival of those forms in which the changes take place better than in their fellows, for it is often not a question of life or death whether or not the process takes place, or even a question of leaving more descendants. On the contrary, it seems highly probable that the regenerative process is one of the fundamental attributes of living things, and that we can find no explanation of it as the outcome of the selective agency of the environment. The phenomena of regeneration appears to belong to the general category of growth phenomena, and as such are characteristic of organisms. Neither regeneration nor growth can be explained, so far as I can see, as the result of the usefulness of these attributes to the bodies with which they are indissolubly associated. The fact that the process of regeneration is useful to the organism cannot be made to account for its existence in the organism." From these conclusions it will be gathered that Prof. Morgan is not attached to the Darwinian or the Lamarckian schools of biological thought; and he provides both of them with much material for consideration.

"Atlas of Practical Elementary Zootomy." By G. B. Howes, ll.d., f.r.s., &c. (London: Macmillan & Co. 1902.)—This volume is a revised edition of the zoological portion of the "Atlas of Practical Elementary Biology," a book well known and highly valued by all the elementary students of biology for the past seventeen years. Little therefore need be said of this revised section. Those, however, who, possessing the complete atlas, imagine that they have no need for the new supplement will make a mistake; for the plates have been increased to twenty-four in number, and are most exquisitely reproduced. Furthermore, Prof. Howes points out in his preface, the contents of this book have been so modified "as to render it more useful to the teacher than hitherto." The author in his preface makes some pertinent remarks on the relation of lectures to the work in the laboratory, which will doubtless, coming from so weighty an authority, command the attention of all those engaged in biological teaching.

We have received from Messrs. W. & A. K. Johnston a copy of their New Century Globe, a twelve-inch Terrestrial Globe, showing the Ocean currents, Date line, and Isothermal lines, and having a metal semi-meridian marked in degrees. The Globe is turned out in the good style we always find in Messrs. Johnston's work, and if we resent the discovery of a new island in the North Pacific Ocean as an advertising station for the publishers, it is only because we feel that the same end could be attained without such a disfigurement.

BOOKS RECEIVED.

Aids in Practical Geology. By Grenville A. J. Cole, m.r.i.a., f.g.s. (Chas. Griffin & Co.) Illustrated. 10s. 6d.

Problems in Electricity. By Robert Weber, d.sc. Translated by Edward A. O'Keeffe, b.e., m.i.e.e. (Spon.) 7s. 6d. net.

Mammalia. By Frank Evers Beddard, m.a., f.r.s. (Macmillan.) Illustrated. 17s. net.

Norwegian North Polar Expedition, 1893-1896, Scientific Results. Edited by Fridtjof Nansen. Vol. III. (Longmans.) 32s. net.

Science of Mechanics. By Dr. Ernst Mach. (Kegan Paul.) Illustrated. 9s. 6d. net.

Leibniz.—Discourse on Metaphysics. Introduction by Paul Janet. Translated by Dr. George R. Montgomery. (Kegan Paul.)

Astronomy with an Opera Glass. By Garrett P. Serviss. (Hirschfeld.) Illustrated. 6s. net.

First Steps in Photo-Micrography. By F. Martin Duncan, f.r.h.s. (Hazell.) Illustrated. 1s. net.

Face of Nature. By Rev. C. T. Ovenden, d.d. (Murray.) 2s.

The Primrose and Darwinism. By A Field Naturalist, m.a.(camb.). (Grant Richards.) 6s. net.

Physiological and Pathological Chemistry. By G. Bunge. (Kegan Paul.) 16s.

Theology and Ethics of the Hebrews. By Archibald Duff, m.a., ll.d., b.d. (The Semitic Series.) (Nimmo.) 5s. net.

Early History of Syria and Palestine. By Lewis Bayles Paton, ph.d. (The Semitic Series). (Nimmo.) 5s. net.

Electrical Installations. By Rankin Kennedy, c.e. (Caxton Publishing Co.) Illustrated. 9s. net.

First Course of Chemistry. By J. H. Leonard, b.sc. (Murray.) 1s. 6d.

Smithsonian Miscellaneous Collections, 1312, 1313, 1314. (Washington: Smithsonian Institution.)

Recognition of the Fourth Dimension. By C. H. Hinton. (Washington: Philosophical Society of Washington.)

Pioneers of Evolution from Thales to Huxley. By Edward Clodd. (Watts & Co.) 6d.

Toronto Astronomical Society: Transactions and Annual Report, 1901. Edited by Arthur Harvey, f.r.s.c. (Toronto: Z. M. Collins.)

Der Untergang der Erde und die kosmischen Katastrophen. By Dr. M. Wilhelm Meyer. (Berlin: Allgemeiner Verein für Deutsche Litteratur.)

Thornton-Pickard Photographic Specialties. Catalogue, 1902.

Catalogue of Photographic Apparatus. (Sanders & Crowhurst.)

NOTES.

Astronomical.—One of the most striking features in the spectra of new stars in their earlier stages is the presence of dark lines on the violet sides of the principal bright ones, one explanation being that which supposes the bright lines to be given out by one body, and the dark ones by another which has a relatively rapid motion towards the earth. The enormous velocity thus indicated, however, has led some astronomers to believe that the pairs of lines are due to other causes. In experiments on the spectra of electric sparks between metallic electrodes under water, Dr. Wilsing found some time ago what he considered to be similar pairs, and suggested that the phenomena were due to pressure. Sir Norman Lockyer has recently repeated the experiments, and in place of the appearances described by Dr. Wilsing he found, among other things, that some of the metallic lines were reversed; that is, in place of an ordinary bright line there was a broader bright line with a dark one down the middle. These reversals, however, were unsymmetrical, the less refrangible part of the bright line being usually brighter than the part towards the violet, so that in an under-exposed photograph the appearances noted by Dr. Wilsing might be reproduced. There is, accordingly, no certain evidence of any connection between the pairs of lines in the spectra of new stars and those described by Dr. Wilsing. Similar experiments made by Prof. Hale appear to yield reversals as the principal phenomena.

Reports from Stonyhurst College Observatory indicate that up to February last the spectrum of Nova Persei continued to show the characteristics of a nebula, but whereas the lines in a nebula are sharply defined, those of the nova are in some cases quintuple, and extend over as much as thirty tenth mètres.

In a continued study of the nebula surrounding Nova Persei, Mr. Ritchey, of the Yerkes Observatory, finds evidence which strongly supports the theory suggested by Kapteyn and others, that the apparent motion is due to changes of illumination in a stationary nebula.—A. F.

Botanical.—The "Flora of Tibet or High Asia" is the title of a long paper by Mr. W. B. Hemsley in the last part of the *Journal of the Linnean Society*. The enumeration of Phanerogams and Ferns shows the flora to consist of 283 species, belonging to 119 genera and 41 natural orders. It is estimated that about 12 per cent. of the species are endemic, but that further research will probably lead to a reduction of this number. The Compositæ are most numerous, there being 53 species, and after them come, in the sequence here given, the Gramineæ, Cruciferæ, Ranunculaceæ, and Leguminosæ, as the most largely represented orders. The flora for the most part consists of very dwarf annual or herbaceous plants, often not exceeding two or three inches in height above the ground, but possessing extraordinarily long tap-roots. Six species are recorded from altitudes of 18,000 feet or more, one, *Saussurea tridactyla*, ascending to 19,000 feet.

In the part of *Hooker's Icones Plantarum* just issued an unusual number of interesting novelties are described and figured, including no less than seven new genera. *Carolinella* (Primulaceæ) is a Chinese plant allied to *Primula*, but having a distinct habit and a circumscissile fruit as in *Anagallis*. *Thomassetia* is an anomalous genus of Ternstrœmiaceæ from the Seychelles, and *Hartia*, belonging to the same order, is from China. The latter is placed near *Stuartia*. *Paradombeya* (Sterculiaceæ) is represented by two species, one from Burma, the other from Yunnan. The flowers of *P. burmanica* are snow-white in a fresh state, but turn yellow in drying. *Diuranthera* (Liliaceæ) resembles *Anthericum*, and differs chiefly in having tailed anthers. This, with the two new genera of Umbelliferæ (*Cryptotæniopsis* and *Carlesia*), are natives of China.—S. A. S.

Zoological.—Specimens of the okapi recently received at Brussels serve to show that the adults of both sexes were furnished with horns, apparently very similar in general character to those of giraffes, being covered with skin. The Brussels specimens comprise the skull of a male and the skin of a female. A small photograph of the skin was exhibited by Dr. Forsyth Major at a recent meeting of the Zoological Society. At the same meeting Mr. G. A. Boulenger showed a strip of skin from the leg of an okapi which had been received in Belgium from Mangbettaland in December, 1899, a year previous to the arrival in this country of the two strips upon the evidence of which *Equus johnstoni* was named.

Another exhibit on the occasion referred to above was a mounted specimen of a wild sheep killed by Mr. J. Talbot Clifton on the mountains bordering the Yana Valley, Siberia, apparently the *Ovis borealis* of Severtzoff, and believed to be the first of its kind brought to England. It was shown to be nearly allied to the wild sheep of Kamchatka, which is itself closely related to the bighorns of North America.

In the June number of the *Zoologist*, Mr. Gunning, of the Pretoria Museum, records the birth of a hybrid between a male ass and a female Burchell's zebra. In general character the mule appears to be much more like its sire than its dam, having no stripes. It is hoped that it may be immune to tsetse-poison and horse-sickness.

The Royal Society has issued the first of a series of reports to the Evolution Committee, describing experiments undertaken by Mr. W. Bateson and Miss E. R. Saunders. These experiments, which have been made both with plants and with poultry, were undertaken with a view of determining whether variations exhibited by animals and plants are distinct phenomena, according as to whether they are continuous or discontinuous. Their result is to fully confirm the truth of "Mendel's Law," of which the essential part is that the germ-cells produced by cross-bred organisms may in certain respects be like one of the pure parental types, and consequently incapable of reproducing the characters of the other. Hence there may be almost complete discontinuity between these germs in respect of one of each pair of opposite characters. This doctrine is likely to have a far-reaching effect on our conception of the origin of species. The experiments are being continued.

STUDIES IN THE BRITISH FLORA.

By R. Lloyd Praeger, B.A.

IV.—THE PROTEAN OFFSPRING OF FERNS.

In my last article the normal forms of our British Ferns were under brief consideration. In discussing the curious phenomenon of apospory, it may have been noticed that, in every instance, this was detected, not in the type form of any species, but in some abnormal variety. The abundance of these varieties in our native Ferns, and their marvellous range of variation, are very remarkable features, well worthy of consideration. In no other group of plants throughout the whole vegetable kingdom do we find such an amazing range of abnormal forms. They are often treated as mere florist's monstrosities, and no more worthy of recognition by the botanist than the rainbow-tinted galaxy of Chrysanthemums or Pansies; but two facts concerning them place them at once on a different footing. First, as many and as remarkable Fern varieties have been found in a state of nature as have been produced by the combined efforts of all the horticulturists; and secondly, a large number of them reproduce themselves absolutely true generation after generation, and are even capable, as we shall see, of carrying (by crossing with other forms) their peculiar characters into other varieties. Furthermore, the features which distinguish these abnormal forms follow certain definite lines even in species of widely separated genera, and are capable of classification. A remarkable point about these Fern varieties is that they are essentially a British group of plants, and their study is a British hobby. While some foreign Ferns yield well-known varieties—such as the crested forms of several species of *Pteris* and Maidenhair—still these are as nothing compared with the wonderful number and range in character of those which have been found wild in our islands, notably in the south-west of England. Another curious point is that the species which are so variable with us appear to lose this character even in neighbouring countries. France and Germany have yielded one or two, but only one or two varieties, where English hedgerows have yielded literally hundreds. These varieties, sports, monstrosities, or whatever we choose to designate them, have occasionally a wide distribution, in which case they frequently obtain recognition from systematic botanists—as *Ceterach officinarum*, var. *crenatum*, *Asplenium Adiantum nigrum*, var. *acutum*, and *Polypodium vulgare*, var. *serratum*, all of which are merely the first stage of the frond-dissection which, as we shall see, is carried immensely further in a number of our common Ferns. In other cases large or small colonies of a variety are formed, as, for instance, *Blechnum Spicant*, var. *trinervium*, which occurs in thousands on the Mourne Mountains in County

Down. But more frequently—and this is a very remarkable fact—a highly abnormal variety, sometimes even one combining *several* quite abnormal features, will occur as a single plant growing amid normal forms, and the most careful search will reveal neither parent nor offspring, in spite of the high fertility of Ferns,* while in cultivation it will propagate freely and preserve its peculiar character. That famous variety of the Lady Fern, *A. F.-f. Victoriæ*, to be presently referred to (Fig. 3), thus occurred in Stirlingshire—a form in which both the cruciate and crested characters are perfectly developed, and are constant in the offspring. The equally remarkable *A. F.-f. Frizelliæ* (Fig. 4), has been twice found in Wicklow and in Donegal—single plants in both cases, which can have had no connection with each other; and innumerable other instances might be cited.

The various British species differ enormously in their tendency to vary. In the forefront of the variety-producing Ferns stand the Lady Fern, Male Fern, Soft Shield Fern, and Hart's-tongue, each of which has yielded literally hundreds of varieties. On the other hand, the Bracken, Parsley Fern, Scale Fern, and Royal Fern, all of which are at least locally abundant, very seldom depart from the normal character. In the Oak Fern, Limestone Polypody, and many rarer species, varieties are unknown.

Let us now see in what directions variation is most marked, and through what species each type of variation runs. The following classification is somewhat rough and ready, and does not cover all known varieties, but it will serve to convey a general idea of the leading lines along which variation has developed:—

		Characteristic Varieties.
1. Alteration of skeleton	A. Branching	*Brachiatum.* *Ramosum.* *Cristatum.* *Acrocladon.*
	B. Widening	*Deltoideum.* *Sagittatum* (Scol.). *Trinervium* (Blech.).
	C. Narrowing	*Angustatum.* *Barnesii* (L. F.-mas).
	D. Dwarfing	*Crispatum.* *Congestum.*
	E. Truncation	*Truncatum.* *Peraferens* (Scol.). *Frizelliæ* *Victoriæ* (A. F.-f.).
	F. Twisting	*Flexuosum.* *Reflexum.* *Revolvens.*
2. Alteration of soft parts	G. Increase	*Plumosum.* *Crispum* (Scol.). *Cambricum* (Polyp. v.). *Pulcherrimum.*
	H. Diminution	*Rotundatum.* *Interruptum.* *Concinnum* (Blech.).
	I. Sub-division	*Tripinnatum.* *Divisilobum.* *Cornubiense* (Polyp. v.). *Projectum* (Scol.). *Crenatum* (Ceterach).
	J. Murication	*Muricatum.* *Lineare.* *Supralineatum.*

* Mr. Druery has calculated that a well-developed *Athyrium* in his garden bears annually *eleven hundred million* spores.—British Pteridological Society Report, 1896, p. 9.

Any scheme of this kind is unsatisfactory, for while many varieties drop into their assigned places, as many more belong to two or even three of the classes. We shall now take each of the classes in turn, and consider the range of its characteristics through the various British Ferns, and some of its most remarkable examples.

A.—BRANCHING.—This is the best known and most widely distributed of the abnormalities of Ferns, offering a great variety of types and running to a greater or less extent through every British species. The cause of this tendency to branch in Ferns does not appear to have been satisfactorily explained. The branching is of various types, of which four of the more frequent are figured diagrammatically below. Every gradation of branching and

FIG. 1.—Types of Branching.
1. Brachiate. 2. Ramose. 3. Cristate. 4. Ramo-cristate.

cresting occurs, from tiny crestlets at the tips of the pinnæ down to that exhibited by the extraordinary Hart's-tongue known as *glomeratum densum Kelwayi*, in which by excessive branching each frond is reduced to a dense hemispherical mass of parsley-like foliage a couple of inches in height. This last-named form is further remarkable for producing on its leafy surfaces innumerable small buds, analagous to the bulbils borne by the Lesser Celandine or Wood Onion, so that we may break a frond into a hundred pieces and obtain fresh plants from every one by half immersing it in soil. Branching in one form or another has been found in many even of our most refractory ferns—the Holly Fern, for instance, *Lastrea æmula*, *Asplenium lanceolatum*, the Parsley Fern, Royal Fern, and Beech Fern. The reader will remember (*see* p. 116 *supra*) that the remarkable phenomenon of apospory occurs in one of the densely crested varieties of the Lady Fern, the tasselled tips of var. *unco-glomeratum* growing out into prothallia if kept in a damp atmosphere.

B.—WIDENING.—A class of varieties that need not detain us. In some forms of *Polystichum* the frond assumes a triangular outline, owing to the lengthening of the lower pinnæ. Other species exhibit an abnormal development of the lowest pair only, thus approximating to the brachiate form of branching figured above. A good example of this is *Blechnum Spicant*, var. *trinervium*, of which mention has already been made. Here the increase of size is accompanied by a sub-division of the enlarged pinnæ. It is interesting to note that the undivided frond of the Hart's-tongue frequently exhibits this character, the base projecting into two lobes, which in a crested form may be themselves crested.

C.—NARROWING.—Not a common nor conspicuous form of variation. One of the most pleasing Ferns in which it appears is a triple variety of the male Fern, *crispa cristata angustata*, the name of which sufficiently describes its characters.

D.—DWARFING.—The skeleton is sometimes dwarfed without a corresponding change in the soft parts, so that pinnæ and pinnules are densely imbricate and overlapping,

FIG. 2.—*Blechnum Spicant*, var. *trinervium*, from the Mourne Mountains. One-third natural size.

and a frond which to judge from the stoutness of its stipe or stem ought to be a foot or two in length is crowded into a length of six inches.

E.—TRUNCATION.—An abrupt suppression of certain parts of the frond is not uncommon, and sometimes produces remarkable effects. In many cases a ragged and unattractive form is the result, but on the other hand two of the most interesting of all wild finds belong to this class. These are the varieties *Victoriæ* and *Frizelliæ* of the Lady Fern, both of which have been already referred to. *Victoriæ*, a single plant found in Scotland, is a cruciate-crested variety. In this Fern each pinna is aborted just

FIG. 3.—*Athyrium Filix-fœmina*, var. *Victoriæ*. Half natural size.

beyond the first pair of pinnules. The latter have consequently the whole burden of food-production, by means of assimilation, thrown upon them, and to get the amount of green surface requisite for this duty these basal pinnules have been enlarged and sub-divided till they almost equal pinnæ in size, and stand out at a wide angle to one another, crossing at right angles those above and below them. The subdivisions of these enlarged pinnules are themselves frequently aborted and cruciate in a similar manner. But in addition, the tips of the pinnæ and frond bear an elegant form of cresting; so that we are lost in wonder as to how this beautifully symmetrical multiple variety can have originated in nature.

This cruciate character (Latin: *cruciatus*, crossed) is known in other forms of Lady Fern, and in *Polystichum angulare* and other species, but its combination in the wild state with cresting is unique. *A. F.-f. Frizelliæ* is another of the most remarkable of natural varieties. In this, the secondary rachis, or midrib of the pinna, aborts at or near the second pair of pinnules; the tertiary rachis aborts also, so that instead of a normal pinna we get a tiny rosette of densely crowded and overlapping pinnules, themselves congested and rounded. The result is not easy to describe, but its appearance is shown in Fig. 5. Curiously enough, in spite of all the crowding, the pinnules remain copiously fertile, and have yielded an abundant offspring. In the Hart's-tongue the truncate character appears in a curious manner. The shortened midrib rises out of the surface, and forms a stiff horn, which often overtops the abruptly rounded termination of the lamina.

FIG. 4.—*Athyrium Filix-fœmina*, var. *Frizelliæ*. Top of frond. Half natural size.

F.—TWISTING.—This character sometimes produces forms which might fairly be called monstrous, such as var. *flexuosum* of *Polystichum angulare*, in which the midrib twists so much that the upper half of the frond is frequently reduced to an inextricable ball. But in other cases the result is more interesting. In var. *revolvens*, for instance, of which excellent examples have been found both in *P. angulare* and *L. Filix-mas*, the pinnæ curve uniformly backwards till they meet behind, forming the fronds into arching tubes. The name var. *reflexum* is usually applied when it is the pinnules that curve backwards. Sometimes this is done so completely that the pinnæ form perfect tubes; more often the pinnule is bent backwards both transversely and longitudinally — a common character in the Lady Fern, for instance, when growing in strong light.

G.—INCREASE OF SOFT PARTS.—Into this class come a large number of the most remarkable and most beautiful varieties. While the first stages of development in this direction consist of foliose or very leafy forms, its full development is reached in the *plumosum* type. Here a great expansion of the divisions of the lamina occurs, accompanied by a papery texture and generally by complete barrenness. This type may, indeed, in many ways be considered analagous to double flowers, since in both the production of the sexual generation—the stamens and pistil in one case, the spore and subsequent prothallium in the other—is sacrificed to leafy growth. The plumose character is found in many of our Ferns. It is in the Lady Fern that it attains its most remarkable development, providing a number of forms of glorious beauty, characterized by a wealth of finely-cut delicate foliage. In the Common Polypody the plumose form is represented by the well-known var. *cambricum*, a very leafy divided form. In the Hart's-tongue, the leafy development produces the complicated overlapping frilling which characterizes the *crispum* forms. A most interesting variety which comes also into class G is var. *pulcherrimum* of *P. angulare*; in this the pinnules are prolonged, and, as recently discovered (*see* p. 115), frequently develop prothallia at their tips. Indeed, the greater number of the known cases of apospory occur in varieties of this leafy class, belonging to the genera *Polystichum*, *Athyrium*, and *Scolopendrium*.

H.—DIMINUTION OF SOFT PARTS.—The varieties which come under this head have little of the interest or beauty that pertains to those of the last. Most of them exhibit an irregular diminution or suppression of the pinnules, the midribs of which being sometimes all that remains, standing out like bristles. Sometimes the pinnæ or pinnules are symmetrically abbreviated, with a rounded margin, as in *P. angulare*, var. *rotundatum*, or a frilled margin, as in Mr. Druery's delightful little *Blechnum Spicant*, var. *concinnum*.

I.—SUBDIVISION.—Almost every Fern varies at least slightly as regards the amount of subdivision which its fronds display. This applies particularly to the species with much divided fronds, such as the Lady Fern and Soft Shield Fern, which may be bipinnate, or sub-tripinnate, or tripinnate, or sub-quadripinnate, according to the size and development of the plant. But this normal variation is wholly eclipsed by the surprising abnormal development which not unfrequently displays itself. A few of the more modest variations of this class have, apparently merely on account of frequent occurrence, been admitted as genuine varieties into the British flora. Thus, the fronds of the Scale Fern are normally merely deeply lobed, but when growing strongly the lobes are frequently themselves lobed, and become var. *crenatum*. Similarly with *Asplenium Adiantum nigrum*, var. *acutum*, a well-marked and wide-ranging dissected form. while in *Polypodium vulgare* not only is var. *serratum* admitted, the analogue of which occurs in almost every British fern, but also the plumose form, var. *cambricum* In *Polystichum angulare* one notable group of varieties comes under this class—the *proliferum* section. The first example of this group was found by Choule, one of the Kew gardeners, over fifty years ago, and was at the time considered to be a foreign fern, so peculiar and well marked were its characters. The frond was elongate, with a very short foot-stalk, tapering upwards from the lowest pair of pinnæ; the pinnules very long and cut into narrow acute pinnules; and the midrib bore buds which developed into young plants long before the frond faded. Fig. 5 contrasts a normal pinna with

FIG. 5.—Pinnæ of *Polystichum angulare*. 1. Normal form. 2. var. *acutilobum*. One-half natural size.

one from a plant of this kind. Since then many examples of the class have been found, notably in Devonshire, and they have been divided into *acutilobes*, in which the anterior and posterior rows of pinnules are of nearly the same length, and *divisilobes*, which show a striking further development of the posterior pinnules of each pinna. The group furnishes many of the most remarkable, constant and beautiful of the myriad varieties of British Ferns But it is not only in the Ferns whose fronds are normally much subdivided that striking development by subdivision takes place. Look at the series shown in Fig. 6 of subdivision in the Common Polypody. The type is seen to have pinnæ quite undivided. Then comes var. *serratum*, which leads the way to var. *semilacerum*, and we finally pass to the marvellous var. *cornubiense*, which when fully developed is almost quadripinnate.

FIG. 6.—Sub-division in the Common Polypody. 1. Normal form. 2. var. *serratum*. 3. var. *semilacerum*. 4. var. *cornubiense*. One-half natural size.

J.—MURICATION.—The last group includes those varieties in which the *surface* of the lamina has undergone alteration. It is chiefly in the Hart's-tongues that this character is found. In numerous forms of that species the surface is broken by ridges and knobs of leafy matter, variously disposed. In var. *supralineatum*, for instance, a narrow raised line runs along the upper surface on each side of the midrib for the whole length of the frond. In others the edges are so lacerated that upper and under surfaces are almost indistinguishable, and fructification frequently appears upon the upper surface of the frond.

Lastly, a word as to crossed varieties. Repeated experiments have shown that the characters of one variety can be transferred to another by sowing the spores of both varieties together, which involves the inference that the antherozoids of one prothallium may pass to a neighbouring prothallium and fertilize its archegonium. Botanists were very slow at first to admit the possibility of this, but the numerous crosses which now exist prove that it can and does occur. The means by which this cross-fertilization has happened without artificial aid has not been made clear. In some cases no doubt a continuous water medium might exist between two prothallia, while certain experiments of Mr. E. J. Lowe's* point to the probability of carriage by small animals. A useful artificial aid consists of a careful flooding of the prothallia with tepid water when the sexual organs have arrived at maturity. One of the earlier experiments of Mr. Lowe was in itself conclusive. A robust normal form of *Polystichum aculeatum* (of which any cruciate variety was unknown) was sown with a narrow cruciate variety (*Wakeleyanum*) of *P. angulare*. Five out of a thousand seedlings obtained were cruciate *P. aculeatum*, of exactly the type of *Wakeleyanum*.† This experiment, indeed, also proves hybridization between the two species—but it may be held that *P. aculeatum* and *P. angulare* are forms of the same species. With this question we are not concerned. The industry of Mr. Lowe, Col. Jones, Mr. Carbonell, and many others, has now given us a multitude of crossed varieties. By selected sowing, cresting has been thrown into a large number of the most famous varieties, such as *A. F.-f. Frizelliæ* and *P. angulare divisilobum*. *Divisilobum* has been crossed with *plumosum*, giving a Fern of marvellous beauty. Even variegation has been thrown into various varieties, and other peculiar characters, such as the fluxuose, congested, and ramose, have been similarly combined by cross-breeding with well marked and constant forms of other character.

* *Journ. Linn. Soc.* (Botany), Vol. XXXII., p. 531, 1896.

† *See* Lowe, in *Annals of Botany*, Vol. III., pp. 27-31, Plate 3, 1889.

Conducted by M. I. CROSS.

POND-LIFE COLLECTING IN JULY. Collecting in July is usually not so profitable as one would expect, because as a rule most of the shallow ponds are dried up by this time, or have been reduced to a muddy swamp, and in the others the Crustaceans, Cladocera and Cyclops, have multiplied to such an extent as to leave little room for the more interesting forms of pond-life. This year, however, is likely to prove an exception to the rule, the weather all through the spring having been quite two months behind its usual season.

Pedalion mirum should be looked for in large and small lakes, as it will probably have greatly increased in numbers. The somewhat rare and very large *Asplanchna amphora* and *ebbesborni*, as well as *Asplanchnopus myrmeleo*, are summer forms which occur at this season. Other Rotifers that appear in warm weather are: *Dinops longipes*, *Triphyllus lacustris*, *Notops clavulatus*, *Scaridium eudactilotum*, and *longicaudum*, then the free-swimming *Lacinularia natans* and *Conochilus volvox*, also the fixed *Lacinularia socialis* and *Megalotrocha*, which are found attached to submerged water plants. All these are very beautiful objects under the microscope, but by no means common.

Volvox globator will certainly be found in abundance now in secluded ponds, and inside the green spheres the little parasitic Rotifer, *Proales parasitica*, should be looked for.

The Polyzoa, mentioned last month, will have become more abundant where they occur; undisturbed ornamental lakes and canals are the best places to find them in.

HINTS ON SECTION CUTTING.—Success in microtome section cutting, no matter what microtome be used, can only be properly attained by dexterity in free-hand section cutting. A few directions which will indicate the manner in which this desirable facility may be secured may, therefore, be of value. It calls for patience, care, and considerable practice.

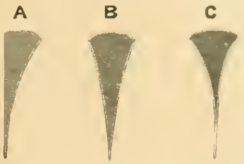
It will be well to select some botanical subjects of small diameter and not too hard in substance to experiment upon, bearing in mind that the smaller the diameter of the material the easier will it be to cut good sections.

The material should be placed in a bottle of 90 per cent. alcohol for three or four days before cutting, and when the operation is in progress, a cup should be provided to receive the razor also containing 90 per cent. alcohol, a saucer with the same spirit in it to dip the material in, and another to receive the sections. A sable-hair brush will also be required of the size known as crow-quill; camel-hair brushes being useless.

The material should be held vertically between the thumb and index finger of the left hand, allowing it to rest in the first bend of the finger and keeping the thumb ¼ inch below the level of the finger. The upper end of the material to be cut should be about level with the finger, the razor being held lightly but firmly, chiefly with the thumb and index finger of the right hand. Well wet the material and razor with the alcohol, place the blade of the razor flat upon the index finger of the left hand and cut the thinnest possible transverse section by either drawing the razor towards you diagonally through the material and cutting from heel to point, or by pushing the razor away from you and cutting from point to heel. As each section is cut, it should be lightly brushed from the razor into the saucer of alcohol, and when, say, one hundred sections have been made, the thinnest and best half dozen may be selected and the process repeated for practice. A further selection of the best may then be made.

It may now be well to say a few words on the implements that are necessary.

THE RAZOR.—Three patterns will be found useful for transverse section cutting, as figured A, B, and C. A, being suitable for large objects, or those harder than the average; B, for general use; and C, for small and delicate objects. Quality of steel and sectional shape go hand in hand with form of blade. The edge should be fairly straight and the heel rounded, not angular; the handle should be one that is capable of being grasped properly. Heavy uncouth razors must be avoided: so also should one having any lettering engraved on its blade. The blade should be as broad as possible, ⅞" being a good width. The razor must be kept free from corrosion, and the edge maintained always at its keenest by careful attention immediately after use.



To set a razor.—The time will quickly come when the edge of the razor will become notched, and in order to restore the edge a hone must be used, a strop being useless for the purpose.

THE HONE.—A very good hone, known as "water of Ayr stone," may be obtained for about 2s. The size of its sharpening surface should be 9 in. by 2 in. Water, not oil, should be used as the lubricant, and it will be found to be a good plan to allow a stream of water to flow continuously over the hone during the whole time of sharpening.

Care should be taken not to scratch the hone. Scalpels, needles, or any other such small instruments should never be allowed to visit it. Having the hone flooded with water, lay the razor flat and diagonally upon the left of the hone in such a manner that the edge of the razor is towards the right, and entirely upon the hone. Draw the razor lightly but firmly edge forwards, and from heel to point along the hone to the extreme right. Turn the razor with a neat action of the fingers combined with a turn of the wrist, its back being kept on the hone, and draw the edge forwards from heel to point as before, from right to left.

Maintain this process to and fro until the notch is removed, remembering always that the lightest pressure will secure the best and quickest results. In fact it is impossible to hone a razor by hard pressure. When the notch is removed by honing, the edge of a razor when carefully examined with a lens × 10 diameters should present throughout its length a straight line, with perhaps here and there a slight fringe or jaggedness standing out from the straight edge, the so-called wire edge. This may be removed by stropping.

The razors, with one side flat, must only be honed upon the concave side, and are more difficult for the novice to sharpen than the other forms. Having dried the razor and returned the hone to its place, we now finish the sharpening by means of the strop.

THE STROP.—Many kinds of strops may be purchased from the dealer. To a new hand the shilling cushion strop will be quite good enough to practise on, subsequently a better strop may be obtained, and the first, although probably damaged by cuts, will be useful for sharpening scalpels. Opinions differ as to the best form of strop, but we have a personal fancy for such as approximate to the following description. A strip of wood, about 13 in. long and 1½ in. wide, has a neat handle shaped at one end, occupying about 4 in. of the length, the remainder forming the base upon which the slightly convex stropping surfaces are built.

Both the stropping surfaces should be of the finest Russia leather. One side is usually charged with the stropping paste, the opposite surface being left bare for finishing. Some strops have the finishing side of buckskin, this we deem wrong for our special purpose, as the velvety buff is apt to impart a rounded edge to the razor. The longer the strop has been in service the better the results obtained, provided that its surfaces have not been hacked. An old friend will have its surfaces hard, smooth and glistening: care should be taken to keep it so. The stropping paste should be applied very sparingly at remote periods and with great care. Black paste should be avoided, as it generally contains emery powder, the red paste is usually of iron-oxide. Good paste can be made by thoroughly mixing the finest jeweller's rouge with the smallest quantity of tallow. Never lay the strop down with either surface in contact with the bench. Avoid belt strops, as the result in inexperienced hands is a rounded razor edge. Holding our ideal strop in the left hand, lay the razor flat and diagonally across the prepared surface of the strop, and with a slight even pressure draw it back foremost, and from heel to point from left to right upon the strop, turn the razor with its back upon the strop and pass it from right to left. Maintain the process as in honing, but back of razor forwards. After several dozen strokes upon the paste side, repeat the work upon the finishing side. Draw the edge of the razor between the finger and thumb or through a piece of elder pith. If the sharpening has been accomplished successfully, a power of 80 diameters upon the microscope will show the edge as a straight unbroken line. This microscopic examination is best made by laying the razor upon a sheet of glass. By allowing the handle to form an angle of 45° with the blade the edge will be preserved from injury; another test is to take a hair from the head, and if the razor will cut it at half an inch from the fingers that hold it, the edge is good.

THE USE OF THE BULL'S EYE.—A correspondent sends the following note with regard to the position of the bull's eye in relation to the lamp and microscope:—

I find that the bull's eye has to be placed in a different position when an ordinary round glass chimney is used to that when a metal chimney with a flat slip of glass is employed. This is probably due to the action of the plane and curved surfaces of the chimneys, and can easily be proved by attaching a piece of tissue paper to a slide; this should then be placed on the stage and the image of the flame focussed through the substage condenser on the tissue paper. The bull's eye should then be set at the best position, the effect being watched on the tissue paper. Now, if the chimney be changed, it will be observed that an alteration of about ¼ inch in the position of the bull's eye will be rendered necessary.

To fill the field of a low-power objective with light when using the bull's eye and substage condenser and an ordinary glass chimney with shade, the best results are obtained as follows:—

The bull's eye should be placed at its focal length from flame, and the distance from flame to mirror should be three times the focal length of bull's eye. When using the microscope horizontally without the mirror, the distance from the flame to the substage condenser should be four times the focal length of the bull's eye.

For instance, if the focus of the bull's eye were $2\frac{7}{8}''$ in the former case, the distance to the mirror would be $8\frac{5}{8}''$ from the flame, and in the latter case the substage condenser would be $11\frac{1}{2}''$ from the flame.

It should be remembered that the plane side of the bull's eye should be set towards the flame.

Mr. W. Mence, of Ouse Villa, St. Ives, Hunts., kindly offers to send a limited number of tubes of *Melicerta ringens* on receipt of bottle and postage, and would be glad to have samples of Mycetozoa in exchange.

NOTES AND QUERIES.

A. Vigar.—Diatom slide, with list of names and comments by the gentleman who kindly acts as consultant for this department, has been returned to you by post.

E. E. Morgan.—If you could now conveniently let me have duplicates of the moss specimens you sent at the end of March last, it is likely that I could get them identified for you.

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.

MR. W. R. BROOKS AND COMETARY DISCOVERIES.—The discoverer of the recent comet may, perhaps, be regarded as the most successful worker in this field of astronomy during the last quarter of a century. Between 1882 and 1892 Mr. W. R. Brooks shared with Mr. E. E. Barnard the honour of finding the majority of new comets, and if we refer to any general summary of results in this department for the period referred to, the names of these able observers will be found to occur with remarkable frequency. But Mr. Barnard relinquished the search some years ago in favour of other important investigations; while Mr. Brooks still devotes himself to it with the same assiduity as ever. In all, he has discovered twenty-three comets, but omitting several objects which were either insufficiently observed, or had been previously detected by other observers, the total number of his discoveries amounts to nineteen. They have ranged over the last twenty years, so that Mr. Brooks's perseverance in sweeping the heavens has furnished us with an average of one new comet in a year. He found thirteen comets with reflecting telescopes of 5 and 9 inches aperture, constructed by himself, and ten comets were first sighted with the 10 inch equatorial refractor at the Smith Observatory, Geneva, New York. Like Messier, Méchain, Caroline Herschel, Pons, Tempel, Winnecke, Swift, Coggia, Borrelly, and Barnard, Mr. Brooks has laboured with conspicuous success in a field requiring great patience and discernment, and the valuable as well as numerous results he has obtained have been often acknowledged, and will be duly appreciated by posterity. It is singular how the course of cometary discovery is maintained without serious break from one generation to another. As soon as one observer finds it necessary to relinquish the quest there is another ready to take it up; thus the firmament is kept under constant surveillance, and every year provides additional discoveries or marks the recognition of a known periodical comet.

THE COMETS OF THE TEN YEARS 1892-1901.—Altogether forty-eight comets were observed, so that the average number was very nearly five per annum. The total included thirty-four new comets, while fourteen were observed returns of periodical comets. Compared with the preceding ten years (1882-1891), these discoveries exhibit no increase, for there were fifty-two comets well observed during the earlier decade.

JULY AND AUGUST METEORS.—With the return of July meteoric students realize that the eve of an important epoch has arrived. The first half of the month is usually not nearly so productive as the last half, and it is rather unfortunate that in 1902 moonlight will interfere during the fortnight from about July 13th to 27th. With clear weather it will be interesting to look for a number of showers in Pegasus, Cepheus, and Andromeda during the first twelve nights of July, while at the end of the month the Aquarids and Perseids will be pretty certain to furnish a considerable number of meteors. At the latter epoch the moon will rise late, and will have waned sufficiently to exercise little influence on the results. Between about July 28th and August 14th it will be well to follow the Perseid display as closely as possible on every suitable night and count the horary number of meteors, as well as determine the positions of the radiant. The maximum of the shower will probably occur before sunrise on August 12th, or just possibly on the following morning.

FIREBALLS.—Several brilliant objects were observed in May, and the following are some particulars:—

May 4, 7h. 35½m.—A pear-shaped meteor of considerable size, and giving as much light as a three or four days' old moon, passed from about 10 degrees S. of the zenith to an altitude of 45 degrees in N.E. Duration about two seconds. Twilight very strong.—E. Rabone, Highgate, N.

This object was seen by another observer in the metropolis, who says it was equal to Sirius, and in the N.E. sky, travelling almost due S. to N. It exhibited a planetary disc of a green colour.

May 16, 11h. 52m.—Fireball equal to Jupiter passed from $212° + 12°$ to $238° + 23°$. Redder than Arcturus. Duration, three seconds. Left a streak.—Rev. W. F. A Ellison, Dublin.

May 26, 10h. 25m.—Meteor nearly equal to Sirius, beneath ρ Scorpii, with scarcely any motion, and only 3 degrees above horizon. Position about $236° - 34°$.—Rev. S. J. Johnson, Bridport.

May 27, 12h. 23m.—Splendid meteor starting from hind foot of Ursa Major and falling nearly to horizon at a point directly in line with the direction of the fore foot. Of a green colour, followed by a short track of fiery light. Motion extremely slow. The first appearance of the meteor was not seen; it died away just before reaching the horizon. Nucleus egg-shaped, with apparently a double tail. Path from about $150° + 45°$ to $125° + 40°$, duration 5 seconds.—E. N. Cullum, Brixton, S.W.—The same fireball was fortunately observed by Prof. A. S. Herschel, at Slough, and he gives the time as 12h. 22m., and the apparent brightness as one and a half times that of Venus. A comparison of the pair of observations shows that the radiant point was in Sagittarius at $282° - 24°$. The meteor moved from a height of 63 miles, over a point 7 miles E. of Shrewsbury, to a height of 39 miles over the sea 20 miles E.N.E. of Douglas, in the Isle of Man. Length of observed flight 120 miles, and velocity 24 miles per second. These figures are only approximate. Additional observations would be very useful.

THE FACE OF THE SKY FOR JULY.

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

THE SUN.—On the 1st the sun rises at 3.48 A.M., and sets at 8.18 P.M. On the 31st he rises at 4.23 A.M. and sets at 7.50 P.M. The earth is at its greatest distance from the sun on the 4th at 1 p.m., when the apparent diameter of the sun is 31′ 30″·6.

THE MOON:—

		Phases.	h. m.
July 5	●	New Moon	12 59 P.M.
„ 12	☽	First Quarter	12 47 P.M.
„ 20	○	Full Moon	4 45 P.M.
„ 28	☾	Last Quarter	5 15 A.M.

During the month the moon occults two 4th magnitude stars, and approaches very near to another. The following are the particulars:—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Reappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
July 3	δ^3 Tauri	4·2	2 3 A.M.	77	112	2 52 A.M.	264	302	26 20
„ 19	ρ^1 Sagittarii	3·9	10 58 P.M.	30	35	11 54 P.M.	307	303	14 9
„ 22	c^2 Capricorni	6·2	8 54 P.M.	356	33	9 6 P.M.	333	9	17 8
„ 24	12 Piscium	6·5	11 30 P.M.	111	144	12 20 A.M.	203	232	19 10
„ 27	ζ^1 Piscium	4·2	1 21 A.M.	157	192	Near approach			22 12

THE PLANETS.—Mercury is a morning star, at greatest westerly elongation of 20° 35′ on the 16th, when he rises in the N.E. about 2.40 A.M., or about 1h. 20m. in advance of the sun.

Venus is a morning star in Taurus, but is becoming more gibbous and dwindling in apparent diameter. Near the middle of the month she rises in the N.E. about 1.30 A.M., or about $2\frac{1}{2}$ hours before the sun. Shortly after rising on the morning of the 29th, she is near the star μ Geminorum.

Mars is a morning star and rises some two hours before the sun.

Vesta, the brightest of the minor planets, is in Sagittarius, near to 51 and 52 Sagittarii. On the 13th she is in opposition, and during the month she is observable as a 6th magnitude star, having a westerly or retrograde path, as shown on the diagram below.

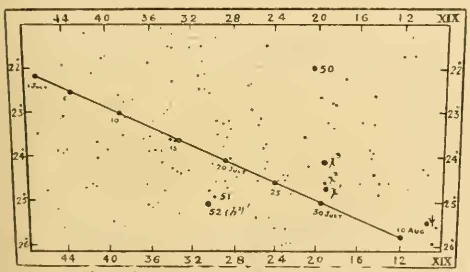


Chart showing Path of Vesta in Sagittarius.

Jupiter now becomes observable before midnight, about which time he is the most conspicuous object looking towards the south-east not very high up. At the beginning of the month he rises about 10 P.M., whilst on the 31st he rises at 8 P.M.

On the 1st, observing about half an hour after midnight, all the satellites will appear in close proximity to each other on the eastern side of the planet, whilst about the same time on the 4th, 12th, 18th, 19th, 21st, 25th, and 27th, three satellites only will be observable, the other satellite being out of view, either in front, behind, or in the shadow of Jupiter.

Saturn is in Sagittarius, being about an hour and a half to the west of Jupiter, and the next most conspicuous object to that planet looking southwards, rather low down. The planet is exactly south at 1.20 A.M. on the 1st, and at 11.7 P.M. on the 31st. He is in opposition to the sun on the 18th at 1 A.M., on which date his apparent diameter is 17″·0. According to Mr. Whitmell, about opposition the earth is so situated with respect to the ring plane, that a suitably placed observer should be able to see a portion of the planet through the large rift in the ring known as the Cassini division, thus a portion of this usually dark interspace should appear bright, being illuminated by the planet's surface behind.

Uranus is in Capricornus, as shown by the chart given in last month's number. Near the middle of the month he is on the meridian at 9.30 P.M.

Neptune is out of range, rising just before dawn.

THE STARS.—About 9 P.M. near middle of the month:—

ZENITH .	Draco, Hercules, Bootes.
SOUTH .	Corona, Serpens, Ophiuchus, Libra, Scorpio.
EAST .	Delphinus, Aquila, Lyra, Capricornus; Sagittarius to the S.E.; Cygnus to the N.E.
WEST .	Great Bear, Cor Caroli, Leo, Virgo.
NORTH .	Ursa Minor, Cassiopeia; Capella on horizon.

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. 4.

Key-move.—1. Q to B7.

If 1. . . . K to Q5,	2. Q to B4ch, etc.
1. . . . K to Kt5,	2. Q to B2, etc.
1. . . . K to Kt3,	2. Q to K7, etc.
1. . . . K to Q3,	2. Kt to Q3, etc.

No. 5.

The composer's intention (1. Q to KB5) is defeated by 1. . . P to K5, 2. Q×B, B to Q5! There is, however, an unintended solution by 1. B to Ksq, ch, and 2. B to QKt4.

No. 6.

Key-move.—1. Kt to B6.

If 1. . . . P×B,	2. Kt to B4ch, etc.
1. . . . B×R,	2. Q to B7ch, etc.
1. . . . R to Bsq,	2. R to K3ch, etc.
1. . . . K to Q3,	2. Q to B7ch, etc.
1. . . . B×P,	2. Kt to B4ch, etc.
1. . . . P×Kt,	2. Q to B7ch, etc.
1. . . . P to Kt4,	2. R×R, etc.

[After other moves there are short mates; and after three moves of the Knight at Kt6 there are dual short mates. Evidently these are one and the same dual. Mr. Johnston alone appears to have discovered it. The composer of the Problem points out that if the board be turned round, White can mate in four moves by 1. R×R, P×B (best); 2. R to K4ch, etc. With this object the otherwise unnecessary Black Pawn at KR7 was added.]

SOLUTIONS received from W. Nash, 4, 4, 4; Alpha, 4, 4, 4; W. Jay, 4, 4, 4; G. Woodcock, 4, 3, 4; G. W. Middleton, 4, 4, 4; W. de P. Crousaz, 0, 4, 0; G. A. Forde, 4, 0, 0; "Tamen," 4, 4, 4; C. Johnston, 4, 4, 5; "Looker-on," 4, 4, 4; H. Myers, 4, 4, 4; A. F. (Rugby), 4, 0, 4; W. J. Land, 4, 4, 0; H. Boyes, 4, 4, 0; J. W. Dawson, 4, 4, 3.

[There may perhaps be some doubt as to whether a dual mate on the second move should count as a dual *continuation.* I am inclined to think that it should, but am submitting the question to Mr. B. G. Laws. Should his opinion coincide with mine, Mr. Johnston's score will stand; otherwise a third and final arbitrator will decide the point.

A. F. (Rugby).—As there is a mate on the move after 1. . . B to Q8, etc., duals resulting in mates on the third move would not count.

W. J. Land.—1. Kt × Kt appears to be answered by 1. . . P to Kt4.

H. Boyes.—See above. After 1. R × R, Kt × R; 2. B to Kt3, B × B, there is no mate.

J. W. Dawson.—The rule printed in the April number reads:—"When a problem has more than one key, no points will be given or deducted for claiming duals." The reason is that when a problem is "cooked," it is immaterial to the judges whether its solutions contain duals or not. Many of your claims for duals in No. 6 are incorrect, but as most of them are for cases in which there is a short mate, no points have been deducted for such claims. One point, however, must be deducted for the claim of a dual after 1. . . P × B. Neither 2. R × R, nor 2. P to B4ch, will meet the case.

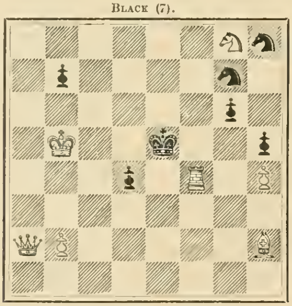
Composer of "Tubby."—Your problem must be disqualified. Castling as a key-move is not legitimate, as there is no proof that White has a legal right to castle.

PROBLEMS.

No. 7.

"Nemo saltat sobrius."

Black (7).



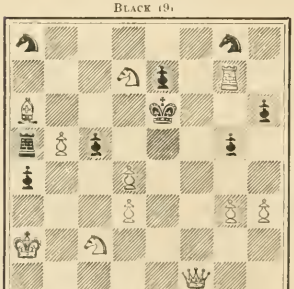
White (7).

White mates in three moves.

No. 8.

"Poor Pink."

Black (9).



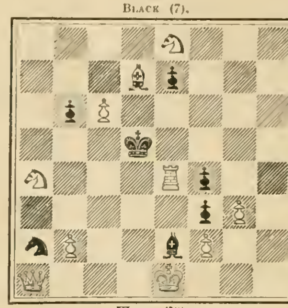
White (11).

White mates in three moves.

No. 9.

"Satis."

Black (7).



White (10).

White mates in three moves.

After the very satisfactory entry for the Problem Tourney, the number of competitors in the Solution Tourney comes as a disappointment. We can only guess that many of the readers of this page either found the May problems exceptionally difficult, or decided that the solving of three three-move problems a month was too much for them. I cannot alter the number at present, but after the end of the year, and in future solution tourneys, the number of three-move problems will be diminished.

SPECIAL NOTICE.

All claims for incorrect scoring of points must be sent in within ten days of the first day of the month of publication. After that date solutions will be destroyed, and claims for altered scores cannot be considered.

CHESS INTELLIGENCE.

Mr. F. J. Marshall, the well-known American expert, has defeated, in short matches, two of our strongest amateurs. Mr. R. Loman lost by four games to two, and Mr. W. Ward by the same majority. Mr. Ward was the winner this year of the City of London Club Championship, Mr. T. F. Lawrence being second, and Messrs. T. B. Girdlestone and H. W. Trenchard bracketed third and fourth.

A correspondence match between Yorkshire and Kent, with 50 players a side, resulted in a win for Yorkshire by $28\frac{1}{2}$ to $21\frac{1}{2}$. At board No. 1, Mr. G. A. Schott, of Bradford, won a brilliant game against Mr. O. C. Muller.

The Open Amateur Tournament of the Kent County Association resulted as follows:—First prize, R. Loman, 7; second, O. C. Muller, 6; equal third, fourth and fifth, R. P. Michell, G. A. Thomas and G. E. Wainwright, $5\frac{1}{2}$. There were five other competitors.

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

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CONTENTS.

THE DEER OF THE PEKING PARKS.

By R. LYDEKKER.

OCTOBER 12th, 1860, will always be memorable as the date of the burning of the Imperial "Summer Palace" in the Yuangming Yuan, the wonderful pleasaunce situated to the north-west of Peking. The Yuangming, which had apparently been hitherto unvisited by Europeans, occupies an area of many hundred acres, and is in fact a park diversified with lakes, and containing a collection of buildings of immense extent, among which was the Summer Palace. The most beautiful part is the forest clothing the flanks of the Hiang-chan hills, which attain a height of a thousand feet, and from which may be viewed at the foot the extensive lake, and in the far distance the walls of Peking enveloped in a smoky haze. Dotted through the gardens were temples, lodges, and pagodas, groves, grottos, lakes, bridges, terraces, and artificial hills. "It certainly was," writes a spectator, "one of the most beautiful scenes I had ever beheld." In the Summer Palace were gathered together all the treasures and curiosities accumulated by the reigning dynasties of China during untold centuries. All these perished in the conflagration, which lasted two days. Whether this burning of the palace, which was ordered by Lord Elgin as a punishment for the atrocities inflicted by the Chinese on British subjects, was justifiable, is not

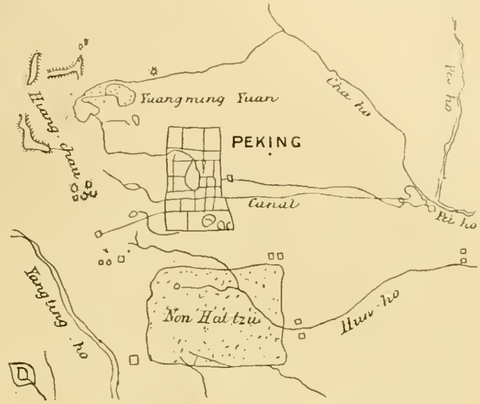


FIG. 1.—Sketch Map of Peking and its Environs.

our province to enquire—Mr. Justin McCarthy, in his "History of Our Own Times," considers that it was.

All that concerns here is the fact that among the *loot* sent home from the destruction of the Yuangming Yuan were the skins and antlers of certain deer which had been shot in the gardens. These specimens, now in the British Museum, appear to have been obtained by Colonel Saul, although Consul Swinhoe was the gentleman by whom they were sent to this country.

Although there does not appear to be any record that such was the case, these specimens may be taken as an indication that among the other attractions of the grounds of the Summer Palace were herds of deer, kept either for the purposes of sport or to enhance the beauty of the landscape. The best of the three specimens sent home was a young stag in the winter coat, of which a coloured figure was given in the *Proceedings* of the Zoological Society of London for 1861. By the late Dr. Gray, then Keeper of the Zoological Department of the British Museum, this deer was regarded as belonging to an ill-defined species named many years before. Two years later this identification was disputed by Mr. Swinhoe, by whom the specimen was regarded as representing a new species, for which the name *Cervus hortulorum*—the deer of the [Summer Palace] Gardens—was, appropriately enough, suggested.

For many years this species was regarded as inseparable from one inhabiting Manchuria, which is now known to be a very different animal. But among the deer now living in the Duke of Bedford's park at Woburn are a herd of a very beautiful species from Northern Manchuria, which has been proved identical with Mr. Swinhoe's *Cervus hortulorum*. These Peking deer (as it has now been agreed to call the species) are remarkable for the extraordinary difference between their summer and winter dress—a difference so great that persons who have seen them at one season may well be excused for not recognizing them at the other. In the summer coat, as shown in Fig. 2, they are of a brilliant reddish chestnut, profusely spotted with white; in winter, on the other hand, when the coat of the old stags becomes very long and shaggy, they are uniformly umber-brown, although traces of spots may persist in the younger stags and hinds. The old stags are but little inferior in size to red deer, with which species certain hinds from the Summer Palace were indeed identified by Mr. Swinhoe, who quite failed to recognize that they were really the adult form of his "garden deer."

Fig. 2.—Peking Stag in Summer Dress, with the Antlers in Velvet.
Photographed by the Duchess of Bedford.

In England the Peking deer seems to thrive as well as red or fallow deer, and in time we may hope to see it established in many of our parks.

But the Yuangming Yuan was not the only park where deer were kept by the Chinese Emperors. To the south of Peking, as shown in the accompanying sketch-map, lies a park known as the Non Hai-tzu (or Nanhai-tze), far exceeding in extent the Yuangming Yuan, the brick wall by which it is enclosed being forty-five miles in circuit. This imperial hunting-park, as it is commonly called by Englishmen, is separated from the city by a plain, which is marshy in places, and gives rise to a river, flowing in part of its course through the park itself. The whole tract is thickly forested, but villages and military posts are dotted here and there in the clearings.

The park was in former days strictly guarded, and no Europeans were allowed entrance, although there are reports that by the aid of disguises a few entered from time to time. According to rumour, the park was the home of large herds of deer of various kinds, as well as of flocks of the Mongolian gazelle, or yellow sheep, as it is called by the Chinese.

Till the year 1865 naturalists had no idea as to the species of deer to be found in the Non Hai-tzu, the Anglo-French expedition of 1860 having confined their attention to Peking and the Yuangming Yuan In February of the former year, however, the well-known French missionary, explorer, and naturalist, Père Armand David, obtained an opportunity of looking over the wall, and was much astonished at the sight which met his eyes. In addition to Mongolian gazelles, he saw herds of a species of deer which he then regarded as an unknown kind of reindeer, although he described it as somewhat donkey-like in appearance, with a long well-haired tail. At that season of the year the stags were without antlers. At the time the energetic missionary was quite unable to obtain a specimen of the new deer, but by bribing the Tatar guards of the park he succeeded in January of the following year in acquiring the skins of a stag and hind. Meantime the French Minister at Peking had been endeavouring to procure a living pair of this deer by diplomatic means, and in February of that year succeeded in his efforts. The stag, however, unfortunately died soon after its removal from the park, and its skin was sent to Paris with those of the two specimens obtained from the Tatar guards

When these specimens arrived at the Paris Museum they were examined by Prof. Milne-Edwards, who in due course described them as representing a new genus and species of deer, under the name of *Elaphurus davidianus.* By the Chinese, it may be well to mention, the animal is known by the name of Mi-lou, or, more commonly, Ssen-pou-siang.

The accompanying photograph (Fig. 3) gives an excellent idea of the external appearance of the stags of this very remarkable and interesting species of deer. To describe its characteristics in anything like detail would obviously be quite out of place in an article of the present nature, and it will suffice to allude to a few of its more striking peculiarities. One feature by which the stags of this species differ from those of all other Old World deer, save the elk and the roe, is that the antlers are of the forked type. That is to say, in place of having a forwardly projecting brow-tine immediately above their base, the main

Fig. 3.—Père David's Mi-lou Stag.
Photographed by the Duchess of Bedford.

shaft, or beam, is undivided for a short distance, and then splits in a fork-like manner. A peculiarity of the mi-lou deer, and one whereby it differs from all the numerous species of American deer carrying antlers of the forked type, is that the hind prong of the main fork forms an undivided tine of great length directed backwards. The front prong, on the other hand, is forked at least once, and has but little forward inclination till the point of bifurcation is reached. The long donkey-like tail, which attracted the attention of the Abbé David at his first sight of the animal, is particularly well displayed in the photograph. The general colour of the coat is fawn-grey, becoming lighter on the face, rump, inner sides of the limbs, and under-parts. Unlike the majority of deer, there is but little change in the colour of the coat according to season. One very curious peculiarity displayed by the stags in the herd of mi-lou deer at Woburn Abbey is that they shed and renew their antlers twice a year, instead of once, as in other deer. Whether, however, this peculiarity has always been inherent in the species, or whether it is the result of long domestication, is impossible to say, for the species is quite unknown in a wild state. Indeed it cannot now be ascertained whether this double change of antlers took place among the herds in the Non Hai-tzu, or even in the specimens first brought to Europe.

The date of the introduction of these deer into the imperial hunting-park is probably very remote, seeing that, as already said, they have never been found wild in any part of Asia by Europeans. It is true that, according to Dr. S. W. Bushell, to whose account refeience is again made in the sequel, a Chinese writer of the latter part of the eighteenth century mentions Kashgaria as the native country of these deer; but even if that be correct, the species may have been exterminated there centuries ago. Anyway, there is but little hope of its survival in that district at the present day.

As China became slowly opened up to European enterprise, the difficulty of obtaining specimens of the mi-lou deer gradually decreased, and in August, 1869, a male and female were received at the menagerie of the Zoological Society as a gift from Sir Rutherford Alcock. A second pair were acquired by purchase in 1883, since the death of which the species appears to have been unrepresented in the Society's collection. Meanwhile specimens were from time to time received by various menageries on the Continent; and the species has bred at the gardens of the Société d'Acclimatation at Paris and elsewhere.

The subsequent history of this interesting and remarkable species is extremely sad, no one apparently having had the least idea that it was on the point of extermination until too late. No definite statements are made by the earlier travellers as to the numbers of these deer in the Non Hai-tzu when they first came under the observation of Europeans. Writing, however, in the summer of 1898 to the secretary of the Zoological Society, Dr. Bushell stated that he had formerly ridden among the herds which swarmed in the imperial park, where they appear to have been reserved for the sport of the Court, and were carefully protected. Whether, in later years, less care was taken than formerly to see that the park and its surrounding wall were in good condition, the account does not state; but during or about the year 1894 the Hun-ho, which flows through the park, became flooded, and breached the wall in several places Through the gaps thus made all the mi-lou deer escaped, and appear to have been killed and eaten by the peasantry of the surrounding districts, who were suffering at that time from famine. In his letter Dr. Bushell promised to make enquiries on his return to China if any of the deer had escaped destruction, but as nothing more has been heard from him on the subject, it may be presumed that all were slaughtered.

Assuming, then, that the mi-lou deer does not exist in a wild state in some unexplored part of Kashgaria, or other remote part of Central Asia, it seems only too evident that its sole living representatives are those preserved in European collections. By far the greater number of these are now at Woburn Abbey, where they run in the open park with the other deer. They breed freely, without an undue proportion of males among the fawns; a very hopeful sign being, that some hinds purchased from Paris, where they were sterile, bred after they were transferred to their new quarters. Some time ago the herd at Woburn numbered over twenty head, and it has probably increased since that date. One point in favour of the prospects of the survival of the Woburn herd is the fact that the species has for centuries been kept in a state of semi-domestication, that is to say, it has lived in an enclosed park without, apparently, any infusion of fresh blood. It would, therefore, seem probable that it will be less likely to suffer from the effects of inbreeding than is the case with animals suddenly transferred from the wild state to captivity. Every care is, of course, taken of these valuable animals, and naturalists will watch with interest the results of the attempt to renew and preserve a decadent and almost exterminated race.

So far as I am aware, Père David's mi-lou deer is the only example of a mammalian species used neither as a food-supply or as a beast of burden which has been preserved from extermination in a semi-domesticated state.

Readers of this article who may be desirous of seeing the mi-lou deer, will find a handsome stag, with fully developed antlers, exhibited in the Natural History Museum, where there is also the mounted head of a female—both the gift of the Duke and Duchess of Bedford. Unfortunately, the taxidermist to whom the task of mounting the stag was confided (and taxidermists are the despair of naturalists, whose name they are prone to appropriate!) took for his model a red deer instead of photographs like the one here reproduced. Consequently, instead of having the slouching, donkey-like carriage so essentially characteristic of the species, the Museum specimen is represented with its head elevated, after the fashion of Landseer's picture "The Monarch of the Glen."

As already mentioned, the mi-lou deer, which is the sole representative of its kind, has no near relatives in the Old World. In spite of a certain not very important difference in the structure of the bones of the fore-foot, it appears, however, to be a not very distant cousin of the typical American deer, that is to say, the numerous species other than the elk, the wapiti, and the reindeer, which are really Old World forms, whose entrance into America is probably a comparatively recent event. Probably both the mi-lou and the American deer are the descendants of an extinct group, with antlers of the same general type, which flourished in Europe during the later portion of the Tertiary epoch. The greater the pity that such an ancient and remarkable type as the former should be on the point of extermination!

VEGETABLE MIMICRY AND HOMOMORPHISM.—IV.

By Rev. Alex. S. Wilson, M.A., B.Sc.

The Fungi are an exceedingly numerous class, exhibiting extraordinary diversity of shape and colouring; many remarkable resemblances are observed among them, but the life-history in several groups is imperfectly known so that the significance of the analogous characters is in many cases still problematical. Odd resemblances to various objects, which can only be regarded as accidental coincidences, are presented by a number of fungi. There is the Jew's-ear fungus, which grows on stumps of the elder, and is so named from its unmistakable likeness to a human ear. The Geasters are curiously like star-

Fig. 16.—Geasters.

fish; Aseröe has an extraordinary resemblance both in form and colour to a sea-anemone; equally remarkable is the likeness to a bird's nest seen in species of Crucibulum, Cyathus and Nidularia. Though most of these are too small to impose on one the resemblance is singularly exact, and a large specimen might almost pass

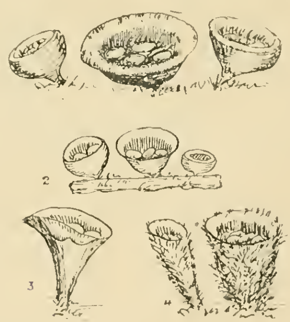


Fig. 17.—Bird's-nest Fungi. 1, Crucibulum. 2, Nidularia. 3 and 4, Cyathus.

for the nest of some small bird, the eggs being admirably represented by the little oval fruits of the fungus.

Even in such cases we must not too rashly conclude that the resemblance confers no advantage. The existence of attractive characters in so many fungi points to the conclusion that the same principles are in operation among them as among flowering plants. Numerous facts indicate a tendency in fungi to assume a guise which helps either to protect the plant or to promote the fertilisation, germination or dispersion of its spores. If, as some mycologists believe, spores benefit through being swallowed by animals, it is easy to understand how a fungus might profit by being mistaken even for a bird's nest containing eggs.

A similar explanation readily suggests itself of the likenesses seen in *Tremella moriformis* and *Licea fragiformis*; as their names indicate the former resembles a mulberry, the latter a ripe strawberry. In his paper on "Mimicry in Fungi," Dr. Plowright (Grevillea, Vol. X.) instances species which present a likeness to the ear of a rabbit or hare, to the liver, brains and entrails of animals, to honeycomb, to tangled horse hair, and in a number of others to the excrement of various animals.

Most toadstools appear to be coloured in strict accordance with the principle of the protective resemblance. Even for an experienced observer it is impossible to distinguish a fading leaf as it lies in the grass in certain positions from the yellow pileus of an agaric. Protective colouring is also well seen among the Pezizas, many of which are clad in obscure tints. Dr. M. C. Cooke (Grevillea, Vol. IX.) has described several species which grow on charcoal or on charred ground and are easily overlooked on account of their resemblance to the blackened soil. One agaric grows on clay, which it closely resembles in colour, several grow among dead pine leaves and are easily mistaken for old pine-cones. Other instances are *Ag. sordidus* on dunghills, *Ag. fusipes* on rotten wood, *Ag. vertirugis* among dead bracken, species of Mycena among dead leaves and twigs, and Paxillus on sawdust. One or two agarics grow among grass and have a green colour corresponding to their environment. The conical caps of *Ag. hypnorum* resemble the calyptra of the mosses among which they grow, while most of the brighter coloured agarics harmonize very well with the bright tints of freshly fallen autumnal leaves. In striking contrast to the gay tints of the fly agaric is the snowy whiteness of its near ally *Amanita nivalis*, an alpine fungus growing on our loftiest mountains.

Besides the scarlet amanita mimicked as we have seen by Balanophora, other attractively coloured fungi are

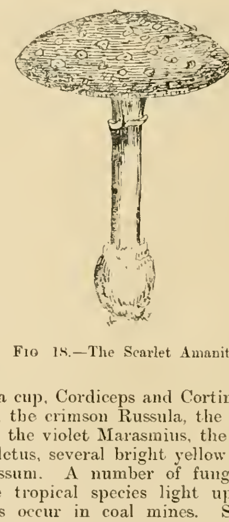


Fig. 18.—The Scarlet Amanita.

the red Peziza cup, Cordiceps and Cortinarius, the coral-like Anthina, the crimson Russula, the amethyst agaric and Clavaria, the violet Marasmius, the purple Russula, the green Boletus, several bright yellow agarics and the black Geoglossum. A number of fungi are phosphorescent; some tropical species light up the jungle at night; others occur in coal mines. Several Polypori growing on dead wood become luminous in the dark.

The odours of fungi are very varied. Clathrus and Phallus are offensive and attract swarms of blow-flies. Lactarius and Hydnum, on the other hand, are sweetly scented like the flowers of Melilotus. Among the odours of fungi enumerated by Dr. Plowright are those of aniseed, mint, peppermint, garlic, horse-radish, cucumber, ripe apricots, rotting pears, rancid herring, Russia leather, gas tar, prussic acid, nitric acid and cacodyle. Like the hemlock, *Agaricus incanus* has the smell of mice, two species of Lactarius have the odour of the common house-bug, while *Hygrophorus cossus* smells like the larvæ of the goat-moth. Fifteen or sixteen species of agaric resemble oatmeal both in taste and smell; *Hydnum repandum* has the flavour of oysters, recalling the oyster plant among the Boraginaceæ, whose leaves have a similar taste. Several are possessed of a nut-like flavour.

The common Stinkhorn, *Phallus impudicus,* is the best known representative of a large family of fungi, the members of which are found in various parts of the world. The Phalloidi include Phallus, Lysurus, Simblum, Clathrus, Aseröe and other genera, all characterized by offensive odours and conspicuous colours. These fungi have been carefully studied by Mr. T. Wemyss Fulton, whose paper on the "Dispersion of Spores in Fungi" in the *Annals of Botany* for 1899 contains many interesting and important observations bearing on mimicry.

Fig. 19.—The Stinkhorn.

Fig. 20.—Clathrus.

The rapid elongation of the stinkhorn is very remarkable; the fungus has been observed to attain a height of several inches in half an hour, furnishing an apt illustration of the proverb that ill weeds grow apace. It not only emits an intolerable charnel-house stench, but its ghastly pallid hue seen against the background of its usual surroundings is peculiarly suggestive of the dead carcass of some animal. Its surface at first exudes a sweetish slime containing sugar, but the hymenium or spore-bearing portion is deliquescent and the entire mass speedily undergoes a series of changes, the white becoming brown, then black, the solid mass being ultimately resolved into a dark fœtid fluid in which the spores are suspended. These mimetic changes, which so closely approximate to those of decomposition, attract carrion flies in prodigious numbers. Blow-flies even deposit their eggs on the fungus, and the maggots seem to develop as though nourished by its substance. On examination Mr. Fulton found the spores adhering in thousands to the feet and proboscides of the insects. Their excrement he found to consist almost entirely of spores, and the latter were proved by experiment to be still capable of germination. There is therefore no doubt in this case that flies are employed as agents in the dispersion of the fungus. This statement also applies to various Coprini and others with a deliquescent hymenium. The spores of Coprinus fimentarius are ultimately contained in a slimy liquid substance having a fœtid odour and eagerly sought after by flies. In this species the pileus becomes revolute and fissured at its margins whereby it acquires a curious superficial resemblance to the flower-heads of some composites, the brownish centre corresponding to the disk and the marginal segments to the white florets of the ray.

THE PLAIN OF PRUSSIA.

By Grenville A. J. Cole, M.R.I.A., F.G.S.

Holland is known as a flat country, where architects have admirable chances; and the same type of scenery continues for some distance to the east, barns, church-towers, and windmills forming the main features of the landscape. When, after some feeling of monotony, and nine hours in the express from Vlissingen, we come in the afternoon to the desolate heath of Lüneburg, we seem about to meet with wilder things. The large undulations of this sandy watershed look mountainous after a morning spent in Holland; vague and perishable roads wander across them; and here and there a single figure, some lost soul of an agriculturist, appears ploughing the soil, which, but for him, would be a heathery and hopeless waste. The railway and the adjacent *Kaiserstrasse*, which is paved with blocks of stone to give it some rigidity, seem the only signs of civilisation.

Yet in time we come to the Elbe, and the forest of masts at Hamburg, and industrial Germany seems to spread before us. So far, in reality, we have only crossed the fringes of the plain. If we follow it to the Russian frontier, our ideas of its magnitude will certainly grow more precise.

The extraordinarily uniform nature of the landscape makes it almost inevitable that one Power should seek to hold this country from the east end of the Baltic to the west, and away beyond, even to the coast of Holland. One by one the minor states have yielded, and the unscientific frontier of Holland still keeps her open to future attack, either by diplomacy or arms. The first political sign of this Baltic uniformity was the establishment, in the thirteenth century, of the Hansa League, which bound the scattered seaports into one powerful federation, ready to defy the Danes and Scandinavians on the north, and to make their own terms with the imperial forces on the south. To this day the Hansa towns form the glory of the Baltic coast.

Once outside the towns, however, the features of the great plain begin afresh. A few miles east of Hamburg, with our backs to the great Lüneburg Heath, which goes off in waves beyond the horizon, we are out in the enormous meadows, where a hundred head of speckled cattle graze within a single field. The red brick towns are succeeded by red brick or timber villages; stone is far too valuable to be used elsewhere than on the roads. The village streets are paved with permanent blocks of granite, syenite, diorite, or other crystalline rocks; the *Kaiserstrassen* are macadamised with uniform fragments of the same materials. Here and there some hillock or cutting reveals the underlying substance of the plain, sand or loose earth in which pebbles and boulders are abundant. In the few places where the bed-rock is known below these layers of detritus, it is not such as to yield pebbles of crystalline rock by any process of decay. Dr. Wahnschaffe* has collected the records of some five hundred borings through the superficial deposits, which reach in many cases a thickness of fifty, and sometimes even of two hundred metres. The beds penetrated lower down are in a few instances of Triassic age, but far more commonly are Cretaceous or Cainozoic. In no case are granitic or even volcanic rocks recorded. White chalk, as is well known, comes to the surface in the cliffs of Rügen on the Baltic; but crystalline masses must be sought in the Harz Mountains or on the borders of Bohemia.

The boulders of the great plain of Prussia are not, how-

* "Die Ursachen der Oberflachengestaltung des norddeutschen Flachlandes" (1901), pp. 18—59.

ever, even of German origin. They prove, as was fairly recognised a century ago, to belong to Scandinavian masses; practically, they have been spread across the land from Sweden. Far from being a product of the waste of Central Europe, as one would suppose from the present direction of the rivers on its surface, the plain represents the filling up of a depression by the flow of material from the north. How has this material crossed the Baltic, and formed, as it were, a widely stretching delta abutting on Saxony and Bohemia? Surely the deposition should have taken place where the Scandinavian streams meet the sea, and not against the opposite shore?

Setting aside some early views, which maintained that the boulders were volcanic bombs showered out from seething caldrons in the north, geologists were led to believe that flood-waters had swept down from Scandinavia; and, later on, it seemed still more easy to account for the drifted material by the agency of floating ice. This explanation would require the submergence of the whole Prussian area in glacial times beneath an extended Baltic sea, the existence of which is at least dubious. At the same time, it leaves the long eskers and other features unaccounted for. The intercalations of marine layers among the "drift" deposits of North Germany are, however, sufficiently numerous to make one regard the area as once occupied by shallow bays and inlets on a shore formed of glacial accumulations. As the ice spread from the north, the earlier deposits were overridden, and no further marine beds could be laid down until the glaciers again retreated. As the ice melted, the burden of stones and sand, largely carried within its mass, became added to the drift and obscured much that had gone before. Making every allowance for the loss of some marine deposits and the effectual concealment of others, it seems, nowadays, impossible to maintain the view that the drift of North Germany, as a whole, was deposited by floating ice. At one time or another, solid ice, highly charged with Scandinavian *débris*, seems to have spread across the whole Baltic region and far towards the central European highlands. Prof. James Geikie's map* represents the extreme position reached by certain glacialists, and is enough to arouse criticism, and to make the supporters of the marine view seek for loose rivets in his armour. Dr. Scharff,† who enters the lists against him, does so mainly on climatic grounds, and urges that certain species of the European fauna have survived (in Ireland, for example) from Pliocene times onward, and that no ice-invasion has occurred over Northern Europe sufficient to crush out animal and vegetable life. He is thus led to regard the German drift as a marine deposit, and the Irish and British glaciers as local phenomena. Neither Dr. Scharff nor the believers in the frequently recurring warmer "inter-glacial" epochs seem to make sufficient use of the well-known Malaspina glacier of Alaska,‡ which spreads out on almost level ground, moving and melting so slowly that abundant vegetable and animal life finds a place upon its surface. It is well to remark, however, that modern observations in high latitudes agree in showing us beds of glacial drift deposited in shallow seas, and subsequently lifted above the water; the Chaix Hills of Alaska are among the most conspicuous examples, and reach 3000 feet in height. Hence both the advocates of continental ice-sheets and those who invoke the sea may find support when they study "existing causes of change." It is not difficult in this controversy to suggest the golden mean; whatever the former elevation both of Scandinavia and Central Europe may have been in early glacial times, it is clear that the floor upon which the ice oozed forth was swaying slowly up and down somewhere near the level of the sea.

When we learn that the rock-floor, which is generally hidden in this area, bears on it the grooves and striations first noted by De Saussure, and now so universally associated with the passage of glacier-ice, we must incline strongly towards the view that ice-sheets have occupied the plain. Dr. Wahnschaffe,* to whose work the present article is so greatly indebted, shows on a map how glacial striæ have been again and again found on rock-surfaces, under the covering of "drift," even so far south as Saxony. Some local glaciers from the Erzgebirge have naturally to be considered when we get into the Dresden area; but the general conclusion of German geologists at the present day is that the Scandinavian ice spread, at one time or another, as a vast sheet over the whole Prussian plain, and deposited its boulders at heights of 415 metres on the Saxon foothills, and even at 426 metres in the Riesengebirge to the east.† The exact figures, however, give us little idea of the thickness of the ice or of the slope over which it moved, seeing how many oscillations the plain of Germany has undergone, in company with the mountain-masses to the north.

If we seek for evidence of these oscillations, and of their impressive magnitude, we may find it in the recent researches of Prof. W. C. Brögger,‡ who urges that considerable submergence took place even while the ice was melting from the margin of southern Norway. The ice-rim thus dropped its burden of sand and boulders§ into a sea in which boreal, but not necessarily arctic, molluscs lived; and here again, as is so often recorded, stratified shell-bearing gravels result, of marine yet at the same time glacial origin. These, by the last emergence, are now lifted high and dry upon the coast-lands. But beneath them the distinctly striated rock-floor stretches seaward, showing that continuous ice occupied the place of the sea in still earlier times, banking it out from the land, or moving over dry ground when Scandinavia was more elevated than now. All these considerations must weigh with us when we set out across the Prussian plain. Broadly, then, we may feel that certain later deposits should be regarded as submarine stratified moraines; yet we cannot overlook the preponderating evidence that a huge confluent glacier-fan once spread across the country.

The phrase *moraine profonde*, applied to the deposits that come to light on the melting of an ice-sheet, has received different meanings during different stages of research. At one time it was presumed by extreme "glacialists" that boulder-clay was at one and the same time accumulated and thrust forward under the ice itself, as a sort of product of the rasping away of the country over which it moved. Modern observation on existing ice-sheets convinces us that the quantity of material which may be carried in the body of the ice, appearing as the mass melts, and becoming stratified by the accompanying wash of water, is quite sufficient to account for boulder-clays and other drift deposits. Such beds have thus a dual origin, and their final disposition is due more to water than to ice. Probably the *moraine profonde* of modern authors must be interpreted as this englacial

* "The Great Ice Age," ed. 3 (1894), Pl. IX., p. 437.

† "On the Origin of the European Fauna," *Proc. R. Irish Acad.*, Ser. 3, Vol. IV. (1897), pp. 488–502. Also "The History of the European Fauna," *Contemp. Sci. Series* (1899), pp. 80–86.

‡ *Thirteenth Ann. Rep. U.S. Geol. Survey* (1892), pp. 19, 26, and 67; *see* also KNOWLEDGE, Vol. XXI. (1898), p. 219.

* *Op. cit.*, Plate 2, p. 91.

† See Jas. Geikie, "Great Ice Age," ed. 3, p. 438.

‡ "Om de senglaciale og postglaciale nivåforandringer i Kristianiafeltet," *Norges geol. undersögelse*, No. 31 (1901), p. 690 (English Summary).

§ *Ibid.*, pp. 687 and 689.

material, which only accumulates as a true deposit when the glacier vanishes away. In this sense it differs considerably from the visible and continuous sheet of moraine-matter which disfigures and conceals the surface of so many glaciers. In this sense also, the material of the Prussian plain may be spoken of as largely originating in the *moraine profonde*.

And what is this plain to-day, stretching far into Russia on the east, but a monstrous development of the drift-covered plain of Ireland? The features seen between Dublin and Galway are here spread out over 500 miles; and that distance only brings us to the further frontier of Ostpreussen. By that time we shall probably have had enough of plains. Yet the surface is not truly level, for rounded hills of loam and sand, stuck full of the characteristic pebbles, occasionally border the road, or are climbed by it between one tract and another. In time we cross the Oder, in its alluvial meadows, between Stettin and Damm, whose harbours are forty miles from open water on this dreary and encumbered coast. In eastern Pomerania the monotonous poverty of the landscape becomes more intense. The forests form the one ennobling feature. Mile after mile of tall slim fir-trees, covering the sandy soil, rising in folds with the undulations of the surface, cutting off the grey-green Baltic on our left and the grey-green lands upon our right, and hiding us, as it were, in ancient Europe, far from the stir of modern times. The bitter wind, which blows even in September, sways the crests of the trees and crashes the stems against one another. The noise overhead, as we rest in the half-darkness, is in strange contrast with the quiet of these forest-depths. Here and there a soft by-road goes off to some well-hidden hamlet; it is the sort of track that in Poland they call a *polska droga*, the typical road of a primitive and undeveloped land.

And so again into the open, to meet the blast that bears with it rain-storms and sudden hail. In the sun-gleam that follows, a cold Baltic sun-gleam, the fields show their patches of brown earth and yellow sand; the ploughing, on such thin soil, does not obscure the boundaries of the underlying drifts. The precious crystalline boulders from Sweden, the handsomest things in the great plain, are removed by the labourers and placed conveniently against the highway. When the Pomeranian highland is reached, where the ground rises at last some 600 feet above the sea, lakes become more numerous, and one may climb for fifteen miles and descend for another fifteen, while the villages adopt almost a châlet style of architecture.

We had thought of the Vistula as the frontier of German preponderance; but both sides prove that the racial lines are as uncertain as the stream itself between its banks of yellow earth. The great waterway is, however, a feature in itself, with cliffs above it in places 200 feet in height, and the antique towers of Mewe or Marienwerder looking out upon the stream. The course of the river from near Bromberg to the Baltic is, geologically speaking, modern. All across the plain, the great rivers receive their longest tributaries from the east.* These, such as the Spree and the Warthe, run so far back from the main streams that it seems as if a trifling further extension would unite them in one great westward-flowing river, leaving the lower Vistula and Oder "beheaded" and diminished. Yet the course of events has been in reality in the opposite direction. The tracing out of the alluvial deposits in old valleys across the plain shows that the great east-and-west river has already existed, and that the lower courses of the Vistula and Oder result from the flowing out north at a later period of water that once found its way into the Elbe.* The Bug, rising in eastern Galicia, joins the Vistula near Warsaw; its waters formerly, as now, followed the present valley of the Vistula as far as Thorn and Fordon, but thence ran on west along the course of the present Netze and Warthe to the valley of the Oder; thence, still westward, to the Elbe near Havelberg in western Brandenburg, and so away to the North Sea. After a time, the water escaped north at a point in Brandenburg, and the lower Oder was formed, flowing to the Baltic; still later, a narrow breach was opened near Fordon in Westpreussen, and the lower Vistula drew off the more eastern part of the water, the former link with the Oder becoming converted into the present Netze. Thus it happens that only diminished streams occupy the ancient valley, while the main flow from the northern flanks of the Karpathians is poured by Fordon, Neuenburg, and Mewe into the Gulf of Danzig. Whatever valley previously existed here has been deepened by the greater flow turned into it, and the notches cut by old tributaries can be seen, left behind, as it were, high upon the yellow cliff.

This diversion of the streams northward, so noticeable on any map of Prussia, has been attributed to local alterations in the tilt of the land, such as are known to have gone on even since the deposition of the drift. A more general cause has been sought in the retreat of the dominant ice-sheet towards the Baltic basin; until this melted away, the rivers could only run east and west along its front. It is conceivable that the retreat was assisted by a downward movement of the Baltic area, and the formation of a slope on which new streams ran towards the ice-front and not away from it. The present river-courses, whatever their origin, clearly arise from the intersection of two separate systems.

At present, modern alluvium is spreading across the wide valley of the Vistula. Thus the old red fortress of Marienwerder, planted on the eastern bank, is two-and-a-half miles from its ferry; and when we cross the river, another level mile brings us to the western bank. At Neuenburg, the town rises directly from the stream; but five miles of alluvium must be traversed before we reach the corresponding cliff upon the east. These figures convey some idea of the scale of the valley, which forms the one great scenic feature of the Slavonic lands of Prussia.

We climb to Marienwerder, and again go eastward. A certain infatuation, such as Napoleon felt in the dreary days of 1806, draws one to the Russian cordon. Enormous ploughed lands, with occasional woods, and lakelets bounded by heaps of glacial drift, are succeeded near Löbau by quite a highland country, in places 800 feet above the sea. Long eskers, the gravel ridges that represent the channels of sub-glacial streams, cross the route, and again remind us of the inland ice. Their association with lakes recalls on a large scale the desolate moorland of Tyrone. Beside the road, boulders four or five feet long are piled up in cairns, while smaller ones peep out everywhere on the surface of the fields.

At length, in a purely Polish country, we reach the cordon and the black and white Russian frontier posts. For eight miles we ride down the border, on a true *polska droga*, through Bialutten, Dzwierzna, and Sczepka, often between the stems of the fir-trees rather than on the deeply grooved and sandy road. Over there, a stone's-throw on our left, the Cossack lancers, in their white shirts and caps, ride to and fro, and keep that arbitrary and unfenced line, which marks the edge of Europe. And here are Illowo and the railway-station; the gate of another Poland opens, and in four hours we shall be in Warsaw.

* Compare Kirchhoff, in Mill's "International Geography" (1899), p. 270.

* Wahnschaffe, *op. cit.*, pp. 175-191, and Pl. 2, p. 91.

DISTANT WORLDS.

II.—A REVIEW OF SOME RECENT STUDIES IN STELLAR DISTRIBUTION.

By C. Easton.

We have just seen by the aid of Stratonoff's charts that if we consider the Argelander stars (mag. 0—9·5) projected on the Milky Way, the great majority of these stars are not scattered in little groups irregularly spread over the whole Galactic zone; but that they are grouped for the most part in a few somewhat large condensations (three or four in the northern hemisphere), whose configuration is not much modified for stars below the 8th magnitude. But here an important question is presented. These great stellar condensations, in Cygnus, Auriga, &c., are they not effaced as soon as we take into consideration the innumerable numbers of stars fainter than those in the "Durchmusterung," that is to say, the multitude of stars of which the Milky Way, properly speaking, is above all composed?

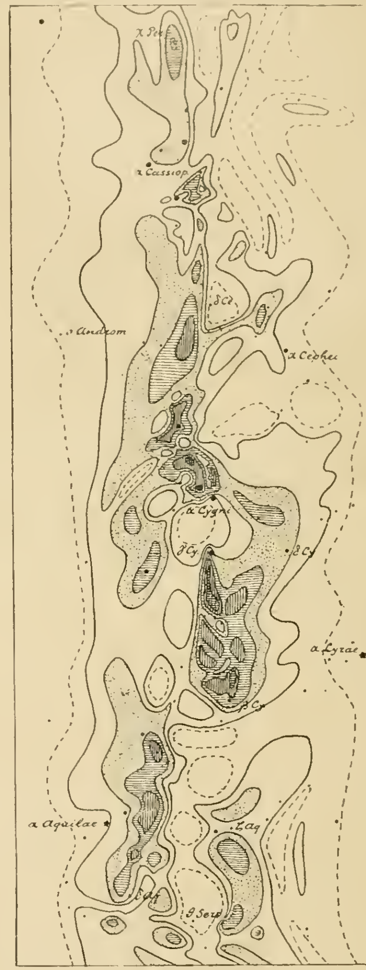
We have already an indication that it is not so; the distribution of stars visible to the naked eye is quite different, whilst a simple inspection of the charts of the Milky Way shows a great analogy between the image formed by the entirety of the small stars and the distribution of the lower classes of Argelander. An interesting research, executed in 1893 by the German astronomer Plassmann, also anticipates the results to which Stratonoff leads us. And I had commenced an enquiry with the object of elucidating this question of a possible "correlation" between the distribution of stars of a medium brightness and the very feeble ones, when Stratonoff's atlas appeared, greatly facilitating my preliminary labours, whilst necessitating the rehandling of the Russian astronomer's data to make them comparable to the values indicating the distribution of the "Galactic stars."

In order to estimate, as precisely as these researches admit, the distribution of the very small stars in the Milky Way, I first constructed an *isophotic* chart of the Galaxy, following the example of the Belgian astronomer, J. C. Houzeau, in 1876, but working according to a different method so as to obtain a much more detailed chart. This chart for the part of the Milky Way which extends from Aquila to Cassiopeia is published here for the first time. Here the curves do not represent, as on the charts of Stratonoff, lines of equal stellar density, but lines of equal brightness (isophotes) of the Galactic light. From this chart I was able to deduce, by a method too lengthy to give here,* numerical values representing the intensity of the Galactic light for equal surfaces of a given size, into which the Galactic zone had been divided, and it is evident that when these values are compared with those obtained for the stellar density of the Argelander stars, calculated for the same surfaces, the divergences which may appear should be attributed to extremely faint stars. We have thus a means of evaluating the richness of the Milky Way in feeble stars, and the particular distribution of these small stars.

But from such a comparison it appears, first of all, that the great condensations of stars that begin to be seen in those of the 8th magnitude are faithfully reproduced—taken as a whole—in the very faint "Galactic stars." This agreement, made by the aid of numerical values, is of much greater weight than the similar conclusion which was already drawn in a general way from the comparison of the charts of the Milky Way with those of Stratonoff.

What is the significance of this phenomenon?

In the first place it is evident that it is not compatible with the supposition that, in the parts of the universe accessible to our observation, the stars, so to speak, form islands in the ocean of space; a great number of isolated groups, *separated from each other by intervals considerable*



Isophotic Chart of the Milky Way from Cassiopeia to Aquila.

as compared with the dimensions of the groups, a supposition which, according to many astronomers, agrees best on the whole with what we know of the structure of the universe. For, in this case, in proportion as the telescope or the photographic camera penetrates deeper into the stellar universe, new accumulations should make their influence felt, and should destroy the image of the stellar distribution produced by the stars nearest to us, and which form but an insignificant fraction of the whole. (All of Argelander's stars constitute but the hundredth part of the whole of Herschel's stars.) On the contrary, we have

* The detailed account of these researches will appear shortly in the *Proceedings of the Royal Academy of Sciences of the Netherlands.*

seen that for the immense majority of the small stars and for those relatively brilliant, the condensations are found to be sensibly in the same regions of the Milky Way.

Again, a uniform distribution of stars that are sensibly equal (Herschel's first hypothesis) is manifestly opposed to what we have found, for in this case we should have to admit that a series of condensations extends, by chance, very far exactly in the line of sight.

Moreover, we may doubt whether we should have here to do with *real* condensations. For we must not forget that if the stars are really of very different brightness, a fairly considerable extension of our system along the line of sight in the direction A, compared with the depth of the system in another direction B, should, according to the laws of probability, produce an apparent excess in the number of stars of all classes in A (even for fairly bright stars, some of which would thus be distant, but in reality exceptionally brilliant or voluminous). And from what we know of the nearest stars, and from the researches of Prof. Kapteyn, it is evident that the differences of actual brightness of the stars are enormous.

But, on the other hand, there is evidence of more than one kind that there really exist in our system condensations; that the "clustering power" already recognised by William Herschel has produced its effect. We have first the theoretical considerations of Celoria, Seeliger and others, bearing on the fact that the Milky Way (actual) is placed in a part of the universe where the stars approach more nearly to each other; then we know there exist a great number of clusters, and that, moreover, they abound in the Milky Way; and, lastly, we have evidence of another order, perhaps less conclusive than the evidence based upon numbers, but not to be despised,—that furnished by photographs. We see there a structure, such that its accumulations must be admitted to be real, with dark lines, the "dark lanes" which have all the appearance of true fissures, as Mr. Maunder has already pointed out.

Thus we may start with two well-based suppositions:—(1) The considerable inequality of the stars in real brightness; and (2) the existence of veritable accumulations of stars. I have wished to exclude at first all suppositions relative to distance.

With the aid of these two suppositions we can explain in effect the principal phenomena of the apparent distribution of the stars. Nevertheless—and this is a fact which seems to me important—these two suppositions are not sufficient to offer a plausible explanation of certain facts brought into evidence in the researches mentioned above. Thus the composition of the Milky Way, its proportional richness in brilliant or faint stars, is very different in different parts of the zone. Whilst the great stellar concentration in Cygnus is already shown in stars relatively bright, another region as dense in Auriga and Monoceros is only evident in stars of the 8th or 9th magnitude, whilst the region between Sagitta and Sobieski's Shield—so brilliant, however, in the Milky Way—only begins to appear in Argelander's last class (9·5), and does not become conspicuous, as is demonstrated in the foregoing researches, until we come to the much feebler stars considered by Celoria (11th magnitude). On the other hand, the structure of the condensations in Auriga and Monoceros is much more homogeneous than that in Cassiopeia and Aquila. Those differences cannot be attributed with any show of plausibility to irregularities of the composition or the condensation of these regions of the Galactic zone; here it is that differences in distance come into play.

The appearance of the northern Galactic zone in drawings of the Milky Way show besides that the whole region between Cassiopeia, Ophiuchus and Aquila is separated fairly clearly by a region in Perseus, thinly star sown, from the other Galactic region which extends over Auriga, Monoceros and Canis Major. In the first region, as we have said, the branch which passes through Aquila and Sobieski's Shield seems more distant than the remainder; but, on the other hand, it has an excess of stars fairly bright or even brilliant near Cepheus and between this constellation and the very crowded region in Cygnus. It is as if this region, extraordinarily rich in stars, brilliant ones as well as feeble, in Cygnus forms a nucleus, from which come off streams which first—in Cepheus—approach the sun, to curve round again, receding more and more when in Cassiopeia, Cygnus and Aquila; to traverse the whole southern hemisphere, ending in Canis Major and Auriga; from this great arm there detach branches into Ophiuchus, Scorpio, etc. The sun is situated inside this gigantic spiral, in a comparatively sparse region of the system between the central nucleus and Orion. Relying on other considerations, developed among other places in KNOWLEDGE (March, 1898), I am disposed to think that such is indeed the structure of the Galactic system; but this view does not allow of a rigorous demonstration.

It may be objected that one of the results of Prof. Kapteyn's, in conformity with the conclusions of B. A. Gould and Schiaparelli, seems not to be in accord with such a disposition of the stars of our Galactic system, for, following these conclusions our sun would form part of a secondary cluster. But we must observe that there may well exist little clusters (Gould computes the number of stars in the solar cluster at seven hundred) in the sparse region of the system, and, besides, Prof. Kapteyn has lately abandoned this idea of a "solar cluster" to which he had been led by considerations, recognised as erroneous, of other astronomers on which he had based it; and as for the conclusions of Gould and others, as these are based exclusively on the apparent brightness of a small number of stars, they have not any great weight.

Prof. J. C. Kapteyn (the well-known collaborator of Sir David Gill, founder of the Astronomical Laboratory at Groningen, and medallist of the Royal Astronomical Society) has continued in the last few years the important researches which Mr. Gore and Miss Clerke have published in their lucid papers in KNOWLEDGE. We know that Kapteyn sees in the distribution of the proper motions of stars a means of increasing very materially our knowledge of the Galactic system. He takes extreme care to eliminate every inadmissible hypothesis and every source of error. And lately Prof. Kapteyn has been occupied with a new method of determining a great number of stellar parallaxes in the same region of the sky, and it goes without saying that a more extended knowledge of stellar parallaxes may lead us to decisive results of the highest importance.

Unhappily, the results obtained so far by Prof. Kapteyn in his last researches scarcely let themselves be extricated from the technical gear of formulæ; and, besides, the researches are not yet finished, and we may not anticipate the result. Thus I will confine myself to mentioning that Kapteyn has succeeded in establishing a formula to express the mean parallax of stars of a given proper motion and brightness, and that he, from this, finds the relative frequency of stars of a determined absolute brightness. In his last publications,* he arrives at the conclusion that the density, the richness in stars of stellar space is much greater than is ordinarily represented; that there exists an excessive number of stars of feeble brilliancy. Kapteyn gives, for example, the following values:—If we conceive

* J. C. Kapteyn: *Public. Astron. Laboratory, Groningen*, VIII., 1901; *Proceedings Royal Academy, Amsterdam*, 1901.

of a region of space containing two millions of stars of the same magnitude as our sun, we shall find that there are 500,000 stars more brilliant, but 12,500,000 stars fainter than our sun.

From the very succinct *résumé* that I have just given of the researches on the structure of the visible universe effected during the last few years—and I have said nothing about the distribution of the nebulæ so as to economise space, though this is a subject very intimately connected with the constitution of the stellar system—it will be evident, I hope, that not only has there been much new material brought together, but that it is possible to draw several interesting conclusions from them.

Perhaps after some years of assiduous work it will be possible to establish more firmly on this ground of truly international scientific effort conclusions which at present are vague and doubtful; perhaps we shall soon see a little more clearly into this sublime mystery of the structure of the universe. In any case, a corner of the veil which has covered it through so many centuries has begun to be lifted.

JUPITER'S GREAT RED SPOT AND ITS SURROUNDINGS.

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

During the last quarter of a century no other planetary marking has incited so much interested attention and study from telescopic observers, as that familiarly known as "The Great Red Spot on Jupiter." The size of the object, the striking aspect it exhibited in the years from 1878 to 1882, its beautifully elliptic form and the extended duration of its visibility, have all contributed to render it a feature of exceptional character. It may, indeed, be almost regarded as unique, and it has certainly served an excellent purpose in stimulating enthusiasm and directing observers to the study of the physical changes affecting the leviathan planet of our system.

The spot has undergone some curious variations. It seems liable to temporary disappearance amid the sea of Jupiter's atmospheric vapours. But through all the vicissitudes and diversity which have affected it in recent years, it appears to have retained an oval shape and a nearly uniform size, though there is evidence to show that its dimensions are now somewhat smaller than formerly. It displayed an intense brick red colour in 1873, and also in 1878 and four following years, but it then faded into a lighter tint, and, subsequently, became an elliptic ring which showed signs of further decadence. Lately, the spot has almost suffered obliteration, having resolved itself into a faint dusky stain, darkest at the following end, and forming but a very feeble relic of the magnificent object presented to us nearly twenty-five years ago. The eye is directed to the exact position of the marking by a remarkable irregularity in the southern side of the southern equatorial belt, in which there is a large bay or hollow immediately north of the spot and partly enclosing it.

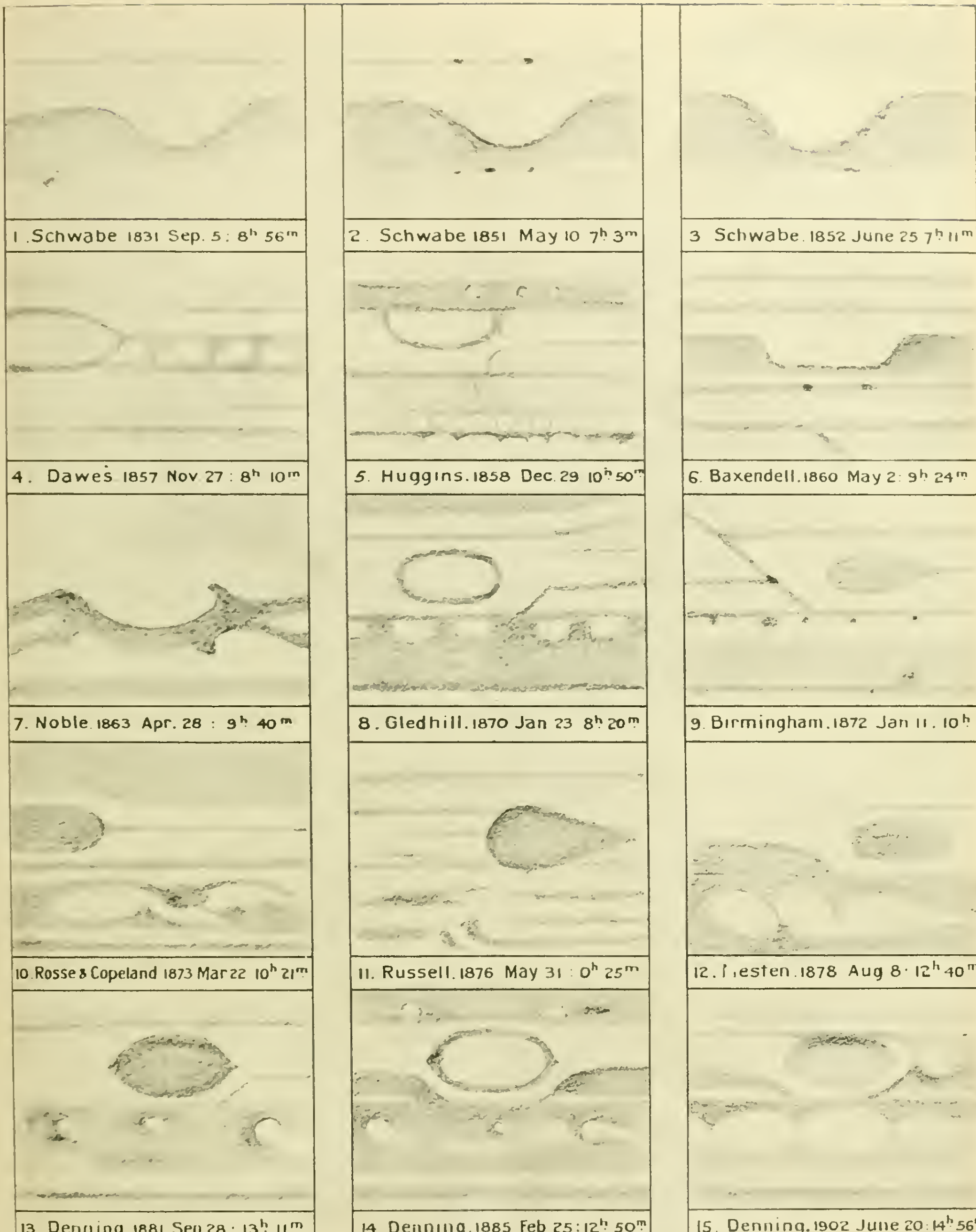
Old observations have not yet been fully investigated, in order to determine the date when the red spot first impressed itself upon the face of the planet. Under the circumstances this will be a difficult point to decide, owing to the want of continuity in the observational evidence. Robert Hooke, on 1664, May 9 (O.S.), was undoubtedly the first to discover a large dark spot on the southern hemisphere of Jupiter; but he does not appear to have made any further observations of it. J. D. Cassini, fortunately, re-detected the object in the summer of 1665, and watched it during subsequent years. He ascertained that its period of rotation was 9h. 56m., and that it had a somewhat precarious existence, for it alternately appeared and disappeared at irregular intervals.

Was the spot discovered by Hooke in 1664, and studied by Cassini in later years, identical with the feature which has enlisted such widespread interest in our own day? There is evidence strongly countenancing the supposition of identity. The latitude of Hooke-Cassini's spot was the same as that of the great red spot, and the motions of the two objects appear to have been approximately the same. But the ancient marking was a roundish object described as one-tenth of the apparent diameter of Jupiter, while the great red spot is about one-fourth. In fact, while the old spot was about 8000 miles in diameter, the present one when most conspicuous was 26,000 miles long and about 9000 miles wide. These differences occasion doubts, without, perhaps, absolutely negativing the theory of identity. Possibly, with the lapse of time, the spot has distended its material in a longitudinal direction as a result of the swift axial rotation of the planet.

In past years there are many breaks in recorded observations of Jupiter, and this is particularly the case between the results of Maraldi (1713) and Sylvabelle (1773). Thereafter W. Herschel, Schroeter, Mädler, Schwabe, and others obtained a considerable number of observations. But there are many missing links and not a few contradictions. It is, however, hard to believe that the red spot could have been plainly visible during the last twenty years of the eighteenth century, and yet have escaped the special notice of Herschel and Schroeter.

Schwabe's drawings in 1831 appear to be the first unmistakably showing the hollow in the belt, which in recent years has contained the red spot. Our knowledge of the aspect and position of the latter enables us to follow it, notwithstanding its extreme faintness. Seventy years ago, when Schwabe's earlier observations were made, the appearance may have been precisely similar to that exhibited at the present time, in which case the feeble ellipse, inlying the hollow, would easily have been overlooked in Schwabe's telescope. Schwabe frequently delineated the hollow under conspicuous outlines between 1831 and 1856, and this feature probably owes its existence to repulsive action exercised by the red spot. It is, however, rather curious that, while the belts north of the spot evade and bend abruptly away from the latter object, the southerly belts occasionally bend towards and coalesce with it.

The red spot is a boat-shaped object (as seen from a vertical position), and it floats in a wide current situated from about 20° to 35° of south latitude. This current has always given a very equable rate of velocity, and the rotation period has been found to be 9h. 55m. 19s. Dark and white spots, and various irregularities on the belts marking this region, all participate in this velocity, but the red spot shows a singular departure from the rule, for it travels slower than the involving stream, and loses 53 seconds per day (nearly half a degree), which is equivalent to about 370 miles. The spot is, in fact, like a great barge slowly drifting eastwards in a wide current. It is probable that the rate of neither the current nor the spot coincides with the exact rotation period of the globe of Jupiter. We have learned the period of the small planet Mars to the tenth of a second (24h. 37m. 22·65s.), for some of the markings displayed on the ruddy Martian surface represent permanent lineaments, which are invariably visible, though the atmosphere of that planet is apt to affect their appearance in some degree. But the conditions are very dissimilar in regard to Jupiter, forming, as he does, an immense orb probably in a very heated state, and with his real features masked by dense gaseous vapours undergoing frequent changes.



REGION OF THE GREAT RED SPOT ON JUPITER.

Though the red spot is now very feebly visible, it may still be intact and in no danger of disappearance. The past history of the object is suggestive that we may expect a repetition of its formerly conspicuous aspect. The hollow in the belt is as strongly pronounced as ever. If it filled up and the south half of the double S. equatorial belt became continuous (without bend or break) in one and the same latitude throughout its circumference, then we should conclude that the material of the spot had really dispersed. But nothing of the kind seems imminent. The past behaviour of the features in this region indicates that when the red spot regains its former prominence the hollow and the southern half of the equatorial belt will decay and probably fade away to invisibility. Possibly the material evolved from Jupiter's heated surface is responsible for the production of the belts and spots on the planet; and the intensification of the belt north of the red spot means that the sustaining material of the latter is being diverted to the belt, whereupon the spot necessarily becomes very feeble. It is certain that the spot and the hollow in the belt have been perceptible either alternately or together ever since 1831, September, a period of nearly 71 years, and that the objects can be distinctly traced on a number of drawings made by various observers during that lengthy interval. And it is quite possible that these associated features of the planet were in visible evidence in the earlier years of last century though they do not appear to have been recognised and to have occasioned special notice.

The following is a general summary of appearances recorded at successive periods:—

1831-1856.—A large and well-defined hollow in the southern side of the southern equatorial belt. —Schwabe.

1857, November.—An elliptical object of considerable size resting upon the S. equatorial belt.—Dawes.

1859-1860.—A large elliptic ring in the southern hemisphere and situated between the S. equatorial belt and the S. temperate belt.—Huggins.

1860-1867.—A great depression or hollow in S. side of the equatorial belt.—Baxendell, Huggins, Jacob, Long, Noble and others.

1869-1871.—A large elliptic ring lying S. of the S. equatorial belt.—Gledhill and Mayer.

1872.—A large oval cloudlike object in S. hemisphere, between S. equatorial and S. temperate belts, and preceded by an oblique belt.—Birmingham, Browning, Gledhill, Knobel, Terby and others.

1873.—Great break in the S. side of the S. equatorial belt.* A brick-red area filled up this break. It was pointed at preceding end and rounded at following end. It extended over some 30 degrees of longitude.—Lord Rosse and Dr. Copeland.

1876-1877.—Large pink spot often seen on S. side of equatorial belt. Rounded at preceding end and pointed at following end.—Russell and Bredichin.

1878-1882.—Great elliptical spot of an intense brick red colour, seen just south of the S. equatorial belt. Length 34 degrees.—Many observers.

1883-1886.—Large elliptical ring situated in a well-marked dip or hollow on the S. side of the equatorial belt.—Many observers.

1887-1902.—Large faint dusky ellipse, varying slightly in tint and tone from year to year, and placed in a hollow in the equatorial belt. Darkest at following end. Outlines not distinctly traceable except on a night of good definition —Many observers.

* The same object was figured by Mr. E. B. Knobel in 1873, April 20, and May 11, when it was on east limb (*Monthly Notices*, XXXIII., p. 476), but it cannot be satisfactorily identified in 24 drawings of Jupiter which he made in 1874 (*Monthly Notices*, XXXIV., p. 403).

The motion of the objects has been by no means uniform during the 71 years; in fact, there have occurred some curious oscillations, as the following brief summary will prove. Throughout the whole time, however, the spot and hollow appear to have exhibited identical rates of motion; a conclusion which is fully justified by the observations.

In 1831-2 the rotation period was about 9h. 55m 33·5s., rising very slowly during the next 24 years, at the rate of about one-tenth of a second annually, until in 1855 it was 9h. 55m. 36·1s. Then the spot exhibited greater retardation, so that in 1859 its period had augmented to 9h. 55m. 38·3s. It then accelerated its movements, and the period declined quickly, until in 1862 it amounted to 9h. 55m. 35·3s. Remaining for some 17 years at about 9h. 55m. 34·5s., another retardation set in in 1879, increasing the period in 1885 to 9h. 55m. 39·6s. From that year the motion continued to exhibit a slight decrease until 1900, when the period was 9h. 55m. 41·9s. In 1901 a marked acceleration affected the position of the object, and the period decreased to 9h 55m. 40·9s. This was continued in 1902, and it seems probable that the motion will undergo a further acceleration in immediately ensuing years.

At the middle of 1894 the longitude of the spot coincided with the position of the zero meridian System II. (daily rate =9h. 55m. 40·63s.) of Mr. Marth's ephemerides. But the retarded rate of velocity during the following six years caused it to drift eastwards, until its observed longitude in 1900, September, was 44½ degrees, and it remained at this value in 1901 and first half of 1902. Should the motion of the spot now continue to increase, and the rotation period become less than 9h. 55m. 40·63s., the longitude of the spot and hollow will, at some future date, again exactly correspond with the zero meridian of System II., as it did in 1894.

In the chart the region of the great red spot is delineated, as it successively appeared at various epochs in and since 1831. It must be confessed that some of the features, as represented, do not offer a very striking similarity, but there seems little reason to question their identity. It is well known that drawings by different observers, owing to variety in method and individual conception, sometimes appear strangely discordant, and that the same details are represented under aspects which bear very slight mutual resemblance. If we allow for this personal equation in the matter of drawing, and for the actual changes which undoubtedly occurred in the objects, and virtually transformed them from time to time, the apparent inconsistencies will disappear. The positions and motion of the markings agree very well together. In one drawing by Sir Wm. Huggins, dated 1858, December 2, a large well-marked hollow was figured a little E. of the centre, but this would not accord with other results in 1857, 1859, and 1860, so that doubts were thrown upon the endeavour to satisfactorily trace back the history of the feature, for the drawing alluded to required the assumption that two hollows existed in the great southern equatorial belt. But it was soon afterwards found that by a clerical error the year 1858 had been assigned instead of 1860, and this being rectified, the position of the hollow was found to harmonize perfectly with other observations. All the collated material exhibits in fact a remarkable consistency, and forms a chain of evidence which appears to be conclusive, as to the identity of the features delineated by Schwabe and many other observers since his time.

In 1873 the red spot is described as pointed at its preceding end, while the opposite end was rounded. In 1877 this figure seems to have undergone reversal, for the sharp end was then on the following side. These alterations of aspect were probably not in the spot itself, but were brought about by the contact of the more swiftly-moving belts on the southern boundaries of the object. The dark end of a short belt or condensation (of which there are many examples in this region), when just preceding or following the spot, might readily induce the appearance of a tapering extremity.

The following selected observations of the hollow, in which the faint relic of the red spot is situated, will sufficiently prove that during the last two years the longitude has not changed relatively to the zero meridian, based on a rotation period of 9h. 55m. 40·63s. The first two transits were obtained with a 4-inch Cooke refractor, the remainder with a 10-inch reflector, power 312, by the writer at Bristol:—

Date.	Transit Time. H. M.	Longitude. °
1900, September 3	7 10	44·4
1901, February 13	17 37	43·5
May 28	13 35	45·9
June 24	10 46	44·7
July 20	12 9	44·8
August 9	8 38	43·5
September 24	6 46	44·5
1902, April 28	16 14	45·9
May 20	14 23	44·7
June 20	14 56	44·8
June 27	15 37	42·2
July 7	13 54	43·9
July 9	15 33	44·5

ASTRONOMY WITHOUT A TELESCOPE.

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

XVI.—THE STRUCTURE OF COMETS.

In the chapter on "Morning and Evening Stars," I pointed out that the systematic observation of heliacal risings and settings offered a chance—a rare one, it is true, but still one not to be despised—of making the first discovery of a comet. Unfortunately comets, bright enough to be visible to the naked eye, have been but very scarce visitants, nor can we reasonably expect that they will be more numerous in the future. Still, when one does come, it justly attracts universal attention; and the "astronomer without a telescope" will naturally be anxious to know if there is any work within his power to effect upon it.

There is. He cannot of course expect to make useful determinations of the comet's place; nor can he scrutinise the changes which take place in the minute details of its head. But the shape, extent, and precise form and position of the comet's tail are better observed by the naked eye than with the telescope; since the eye can embrace a far wider field, and is the fitter instrument for dealing with great extensions of faint light. To map out, night by night, the precise position of the tail or tails with reference to the neighbouring stars, to trace its limit and to determine its exact form, are by no means unimportant tasks.

And for this reason. The last thirty years have seen the development and gradual acceptance of a theory which explains the origin and structure of those far-stretching wisps of light which our forefathers found so mysterious and awe-inspiring. The first step towards the elaboration of this theory was made by Olbers nearly a century ago in a memoir on the great comet of 1811; but in its present shape we owe it to Prof. Brédikhine, lately the Director of the Poulkova Observatory.

It was very early noticed that the tails of comets are in general directed away from the sun, and the instance of certain comets, which passed at perihelion very close to the solar surface, was sufficient to prove that we must not regard a comet's tail as forming a body coherent with the head. Thus the great comet of 1843 swept round some

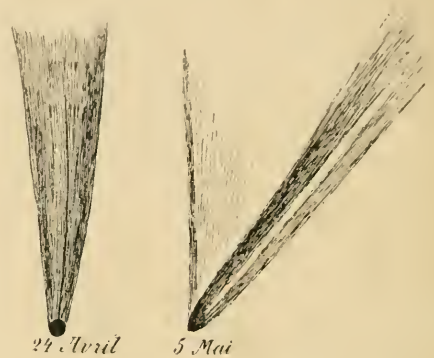


Fig. 1.—The Comet of 1901 on April 24 and May 5.

180° of longitude at perihelion in something like eighteen hours of time. The tail which had been seen before perihelion, pointing away from the sun in one direction, could not possibly have been composed of the same material as made up the tail, lying in the opposite direction after perihelion. But if it were supposed that the sun were capable of exercising a repulsive force upon some portion of the substance of the comet, driving it off in a continuous stream, then the general behaviour of cometary tails would be accounted for. The tail, seen at any

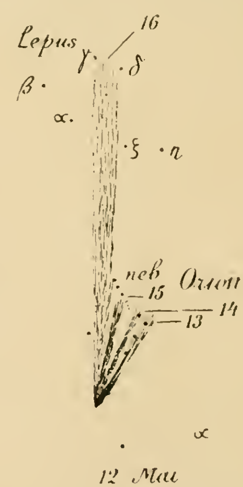


Fig. 2.—The Comet of 1901 on May 12.

particular time, would be the summation of particles which had left the comet at different successive instants, just as the trail of smoke from the funnel of a locomotive, as seen at any particular moment, is composed of particles that came off from it at successive instants, and is not a body coherent with the engine.

Such a repulsive force we may find in an electrical action of the sun, an action, the efficiency of which would depend upon the surface of the body acted upon; as contrasted with that of gravitation, which depends upon its mass. Thus whilst the nucleus is moving in its orbit round the sun under the influence of gravitation, very minute particles in the envelope will find themselves practically less strongly attracted towards the sun, or it may actually be repelled from it; in any case the effect is to separate them more and more from the main body of the comet.

Of the particles thus driven away from the head, the lightest would be those most strongly repelled; and Prof. Brédikhine found that several of the great comets of the past century were distinguished by the possession of long straight tails which must have been composed of particles moving under an influence some twelve or fourteen times

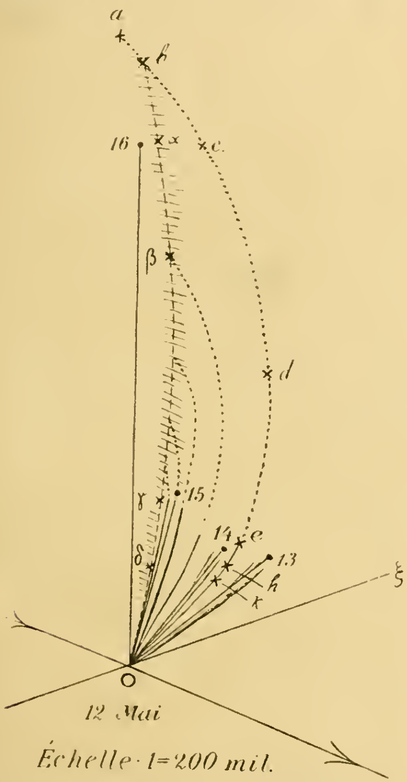


Fig. 3.—Prof. Brédikhine's analysis of the tail of the Comet on 1901, May 12.

that of gravity. These long straight tails form an exceedingly characteristic class, and have accordingly been ranked by Prof. Brédikhine as composing his first type. Such tails are obviously composed of the lightest material entering into the composition of the comet, and assuming this to be hydrogen, then the average tail of the second type might well be made up of hydrocarbons; whilst iron and the heavier metals would, from their molecular weight, be suitable elements to form the third type. In the tails of the second type the effective repulsive force does not differ greatly from gravity, and it is this type of tail, slightly, but not extravagantly curved, which is most commonly observed in comets visible to the naked eye. The third type is usually sharply curved, short and brush-like, and the repulsive force is considerably less than that of gravity.

The great comet seen in the southern hemisphere in April and May, 1901, has recently been analysed by Prof. Brédikhine, in a paper from which the three accompanying diagrams have been reproduced, and his results afford an interesting example of his method of treatment, and of the use which can be made of careful naked-eye observations of the positions of a comet's tail.

On April 24th, before the perihelion passage, the comet showed practically only a single tail, and that was of the first or hydrogen type. After perihelion, the tails were only of the second and third types, the matter composing the first type tail having been apparently completely driven away. On May 5th, the chief tail, which was distinguished by a very well marked rift, showed this rift as of a conical shape, the apex of which was occupied by the nucleus, and not as usual of a conoidal form. A drawing made by Mr. J. Lunt at the Royal Observatory, Cape of Good Hope, on May 12th, was of especial interest It not only showed the principal tail of May 5th with its dark rift, but a long broad faint tail some 25° in length, and a short tail between the two. Prof. Brédikhine's analysis of this drawing is given in the accompanying diagram. The lines 13 and 14, the two branches of the principal tail, were due to a repulsive force a little greater than unity; the line 15 is due to a force of about 0·65; the broad faint tail, Prof. Brédikhine ascribes to substances of the third type, and finds that when the particles which make it up are traced back to the nucleus they indicate that a great explosion took place on April 22nd; a vast quantity of matter of a wide range of density being driven off in a single short-lived convulsion. The points in the diagram, α, β, γ and δ, correspond respectively to values of the repulsive force of 0·85, 0·65, 0·25 and 0·15.

Letters.

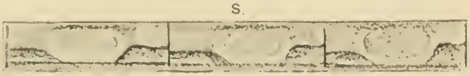
[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

MARKINGS ON JUPITER.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Last year there was a large dusky mass situated between the south side of the equatorial belt and the south temperate belt of Jupiter, and joining the two. In 1901, June 18th, the longitude of the marking alluded to was 258°, while on November 17th of the same year it was 176°. During five months it gained, therefore, 82°, its rotation period being 9h. 55m. 18·5s., while that of System II. of Mr. Crommelin's ephemerides was 9h. 55m. 40·63s. This dusky mass, placed in the usually bright tropical zone of Jupiter, is still conspicuously visible, and has greatly distended itself since last year in a longitudinal direction. On July 2nd I observed it with a 10-inch reflector, power 312, and found its p. side on the central meridian at 13h. 51m., while its f. side came to the C.M. at 16h 16m., or 2h. 25m. afterwards, so that the formation extended over 87°·6 of longitude. At the present time it lies both E. and W. of the old red spot and hollow in the south belt, which is in longitude 43°.

Though the dusky mass is now passing the red spot, the latter is no darker than usual, and it seems highly probable that the sombre material of the former as it overtakes the red spot is drifted abruptly southwards, flowing along its southern borders and then on reaching the *p.* side of the latter it turns sharply to north and thus occupies the same latitude both east and west of the red spot. The *f.* end of the south tropical (or temperate) mass



Red Spot and its Surroundings.

will come up to the *f.* end of the red spot at the beginning of September, and it will be important to ascertain whether the extremity of the former flows southward.

Telescopic observers should keep a diligent watch during ensuing months on the developments in this exceedingly interesting region of Jupiter.

Between 1900, September, and 1902, June, the mean motion of the red spot conformed precisely with the period of 9h. 55m. 40·6s. on which System II. of the ephemerides is based, for its longitude remained consistently at $44\frac{1}{2}°$. Lately, however, the spot has indicated a slight acceleration in velocity, for its longitude appears to have decreased 2° or 3°, and it is likely that it will show a further decrease in succeeding months, for the past history of the spot sufficiently proves that it is liable to some marked fluctuations in its rate of motion.

Bishopston, Bristol, W. F. Denning.
1902, July 4th.

A MODERN TYCHO.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—My attention has been called to an article by Mr. E. Walter Maunder in your issue of May, 1902, entitled "A Modern Tycho," in which the following sentence occurs :—"Jey Singh does not seem to have effected any reformation of the Indian calendar, and his observatories, despite their great size, cannot have been of much value for really scientific work."

I would ask your correspondent if he has ever seen an account of the "Zeech Mahommed Shahi," or Jey Singh's astronomical tables, published by him, after years of observation at his observatories, about 1728. In the preface to these tables Jey Singh states that the old Siddhantas give incorrect results, that at Mahommed Shah's request he had erected several observatories, and that after many years' labour he had succeeded in producing these tables according to the prediction of which the celestial phenomena take place exactly. He also adds that hearing astronomical observations were being made in Europe, he had sent thither to make enquiries, and that as a result he had obtained the tables of de la Hire, which on examination proved very inaccurate. There is an account of the "Zeech Mahommed Shahi," by Dr. W. Hunter, in "Asiatic Researches," Vol. V., but, as far as I know, these tables have never been thoroughly examined by an expert with a view to test their accuracy. I was informed the other day by a native astronomer, fairly well acquainted with the modern methods of practical astronomy, that these tables generally give results not often more than two to four minutes in error. If this is so, Jey Singh's work must have been of a high order, and of considerable scientific value. I hope to obtain a complete translation of these tables shortly, and have them properly investigated by a competent expert.

But, putting aside the question of the accuracy of these tables, there is no doubt that some of Jey Singh's astronomical measurements are as precise as have ever been attained by naked-eye work. The inclination of the face of the gnomon of the big instrument at Jeypore is within a minute of arc of its correct value. Jey Singh's determination of the latitude of Jeypore and Ujjain are certainly within half a minute of the truth, and possibly even closer, while the value he deduced for the obliquity of the ecliptic is of an equally high order of accuracy. The value he gives for the average annual procession is, if my memory serves me right, within a second of the modern determination.

During last summer I was engaged in restoring the observatory at Jeypore, and had ample opportunities for testing and investigating the instruments. Their accuracy was shown by the excellent agreement in the results obtained by observing altitudes, azimuths and declinations with different instruments. Jey Singh was a good mathematician, and wrote many works on astronomy and trigonometry. Under these circumstances it seems probable that the "Zeech Mahommed Shahi" are a very great improvement on the old Siddhantas, though possibly not possessing the accuracy which Jey Singh claimed for them.

Mr. Maunder writes rather disparagingly of Jey Singh, who, as I have shown above, certainly obtained very good results, and did the best he could for the advancement of astronomy with the limited means at his disposal. It should be remembered too that Jey Singh lived in very troubled times, and that the very existence of his State was constantly being threatened both by enemies from without and intrigues from within. Indeed, considering the state of affairs at the time, it is wonderful that Jey Singh ever found leisure for the erection of his observatories, and the writing of his books. A. ff. Garrett, Lt. R.E.

India, June, 1902.

[I had no wish to disparage Jey Singh, who, as Mr. Garrett most truly says, lived in very troubled times in the which it was wonderful that he found the opportunity for accomplishing so much scientific work. But I think that Mr. Garrett has missed the point which I was really anxious to make. I have only had the opportunity of myself examining one of Jey Singh's observatories—that of Delhi—but I was much impressed with its limitations for really good observational work. The gnomon, after all, despite its great size, would have given no better determinations of time than a comparatively small sun-dial, while the circular buildings only permitted the observation of altitudes and azimuths of objects when low down, and I saw no indication that any great care was taken about the precise position of the observer's eye.

And the accuracy with which the various buildings are placed—as, for example, the inclination given to the face of the gnomon—so far from bearing witness to any improvement effected by the observatories, is proof just the other way. For Jey Singh must have determined the latitude of the place with this precision before ever he started to build; he could not have altered his gnomon afterwards. For this purpose he probably used quite a simple apparatus of poles fitted with sights; and it was the superior efficiency and range of usefulness of just such simple means that I had chiefly in view in my paper. Jey Singh's observatories are most certainly interesting, but they are scarcely practical.

I am glad to note that Mr. Garrett hopes to obtain a complete translation of Jey Singh's tables ere long; but I venture to think that it would be of even greater interest to astronomers if he would himself undertake a series of observation of stars and planets with the Jeypore instruments as they stand.—E. Walter Maunder.]

NOTES.

Botanical.—Parthenogenesis has been discovered by Mr. J. B. Overton in *Thalictrum purpurascens*, and is the subject of a paper in the May number of the *Botanical Gazette*. Another species (*T. Fendleri*) was suspected to exhibit this phenomenon. In 1896, Mr. D. F. Day wrote that he had grown pistillate plants of this species, and although no staminate plants of any species of *Thalictrum* were in the neighbourhood, an abundance of good seeds were produced. As it seemed doubtful whether this was a case of parthenogenesis or of vegetative apogamy, Mr. Overton undertook a careful study of the development of the embryo of *T. purpurascens*, in which fertilization could not possibly have taken place. He determined that in this plant fertilization is not necessary to embryo-development or to endosperm-development, that embryos were produced parthenogenetically under all conditions, and that the development of the embryo in parthenogenetic material is the same as in normal material.

Among the plants which are adapted by their peculiar habit of growth to serve the office of sand-binders and beach-builders, as illustrated by the British *Psamma arenaria*, is the extremely interesting Naiadaceous genus *Phyllospadix* or Eelgrass. This, as Mr. R. E. Gibbs states in his paper on the plant in the *American Naturalist* for February, grows in extensive beds in shallow water along the rocky shores of Bodega Bay, California. Its fruit is furnished with two arms, and after it has detached itself from the parent plant, these arms ultimately become barbed in consequence of the wearing away of the softer tissues through friction with rocks and stones, which exposes a series of elongated lignified cells. These cells stand out as strong barbs, enabling the fruit to anchor on branches of sea-weeds. It is commonly found on *Amphiroa*, the segmented stems of which provide a firm resting place. The seed then germinates, and gives rise to a thick mattress of rhizomes, covering boulders and binding stones, sand and other material firmly together, thus forming a "more coherent and stable foundation of the beach."—S. A. S.

Zoological.—In a paper published in the June issue of the *Proceedings* of the Zoological Society of London, Dr. Ludwig von Lorenz describes and figures a mounted specimen of a quagga preserved in the Imperial Museum at Vienna. As this example differs somewhat in its markings from other specimens, the author suggests that there may have been two or more local races of this now extinct species.

The fossil voles of the Norwich Crag and the Pliocene deposits of the Val d'Arno form the subject of a communication by Dr. Forsyth Major to the journal just quoted. The forms characterized by having rooted cheek-teeth the author proposes to designate by the new generic term *Mimomys*, naming one of them *M. newtoni*, in honour of Mr. E. T. Newton, the well-known describer of Crag vertebrates.

In concluding an account of his investigations on the phylogeny of the dentition of the hedgehogs and their allies, published in the *Zoologica*, Dr. W. Leche, of Stockholm, expresses the opinion that the European Oligocene genus *Necrogymnurus* is the oldest representative of the family known to us. From this have sprung two branches, one including the extinct *Galerix* and *Lanthanotherium* and the modern Bornean *Gymnura*, and the other the true hedgehogs (*Erinaceus*) and the Malay *Hylomys*.

Dr. Gadow, of Cambridge, in a paper on the origin of mammals contributed to the *Zeitschrift für Morphologie*, sums up as follows:—"Mammals are descendants of reptiles as surely as they have been evolved from Amphibia. This does not mean that any of the living groups of reptiles can claim this honour of ancestry, but it means that the mammals have branched where the principal reptilian groups meet, and that is a long way back. The Theromorpha, especially small Theriodontia, alone show us what these creatures were like." It may be explained that the Theromorpha, or Anomodontia, are those extinct reptiles so common in the early secondary deposits of South Africa, some of which present a remarkable resemblance in their dentition and skeleton to mammals, while others come equally near amphibians.

As the result of his explorations in North-Eastern and Eastern Africa, Mr. Oscar Neumann has been able to determine a number of new species, including a guereza and several other monkeys, a jackal which he names *Canis kaffensis*, a harnessed antelope called, in honour of the Emperor of Abyssinia, *Tragelaphus meneliki*, together with several other members of the same group, and two "dassies," or hyraces (*Procavia*). The descriptions are published in Nos. 3, 4, and 9 of the *Sitzungs-Berichte* of the Berlin Naturalists' Society for the present year.

Mr. O. Thomas, of the British Museum, in the June number of the *Annals of Natural History* is able to announce that at least three local forms of that remarkable animal the African hunting-dog (*Lycaon pictus*) can now be recognised, namely the typical Mozambique race, the Cape race, and the Eastern race. As showing the absolute necessity of having large series of specimens of animals in our museums, the following remarks of the author are worth quotation: "Owing to their peculiar irregular coloration," he writes, "specimens of *Lycaon* are particularly difficult to compare effectively with one another, and still more to describe in an effectual manner. As is well known, no two individuals, even if from the same pack, are precisely identical, and it is only by the general average coloration that one is able to distinguish the local races at all."

British Ornithological Notes.

Conducted by W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U.

Wild Birds' Protection Acts.—The *Field*, June 21st, contains some interesting comments on the numerous amendments to these most salutary Acts, amendments which, it must be admitted, though framed with the best intentions, have not always been wise, and have not infrequently failed to effect the object aimed at. The latest amendment is contained in a Bill introduced by Lord Jersey, and passed through the third reading in the House of Lords during the second week in June. According to this Bill, any person convicted of an offence against the Wild Birds' Protection Acts, 1880–93, may be condemned by the Court, in addition to the penalty imposed, to forfeit any wild bird, or wild birds' eggs, in respect to which the penalty was imposed. The forfeited property is to be disposed of as the Court may think fit. The need of such an Act has long been felt. Hitherto, in the case of rare birds or their eggs, the fine imposed acted by no means as a deterrent, forming, as it did, but a small fraction of the value of the specimens now to be confiscated.

Acquired Habits in Wild Birds.—Mr. W. B. Tegetmeier, in the *Field* of June 28th, makes a few observations on certain "acquired habits" in the Sparrow, Rook, Titmice, Thrushes and Starlings. Some of Mr. Tegetmeier's remarks caused us some surprise and not a little sorrow, but perhaps we have taken them too seriously. We feel certain that his remarks concerning the value of birds as insect destroyers are not supported by fact, and are calculated to do some harm—perhaps much harm.

Abrupt Variation in Indian Birds.—Mr. Frank Finn, in the *Journal of the Asiatic Society of Bengal*, Vol. LXXI., part II., 1902, contributes some interesting observations on albinistic variations. The most noteworthy of these are furnished by the Ruff (*Paroncella pugnax*). In a considerable number of specimens, mostly males, Mr. Finn finds the winter plumage characterized by a white head, and white mottlings in the body plumage. Since this variation occurs only in old birds, Mr. Finn is inclined to regard it as a species of senile albinism. Some strong and vigorous birds, however, also appear in this white-mottled and white-headed guise, and in consequence the author seems to change his view of the significance of the variation, and to hold that it is a well-marked and definable form, liable to recur again and again. Such recurrent aberrations, he thinks, it is desirable to distinguish by a sub-specific name, proposing therefor *Paroncella pugnax lecoprora*. Important, and in every way worthy of record such variations certainly are, but we venture to doubt whether the bestowal of specific names on such forms is justified.

White-fronted Goose Nesting in Captivity.—Mr. F. W. Frohawk, in a letter to the *Field*, July 5th, records perhaps the only authenticated instance of this bird breeding in confinement. The pair of birds which have achieved this fame belonged to Mr. J. S. Green, of Blackheath. Five eggs were laid, but of these only one has hatched out. It is to be hoped that the gosling will reach maturity.

Rheas Breeding in Captivity.—Major Fothergill, in the *Avicultural Magazine* for May, records some extremely interesting facts about the nesting habits of the Rheas in his possession. We are much tempted to quote therefrom, but space forbids.

Noteworthy additions at the Zoological Gardens.—We draw the attention of our readers to the fact that three specimens of Darwin's Rhea, six ruddy Flamingoes, and a Great Bird of Paradise *(Paradisea apoda)* have recently been added to the Society's collection. All are in good health, and well worth a visit.

All contributions to the column, either in the way of notes or photographs, should be forwarded to W. P. Pycraft, *at the Natural History Museum, Cromwell Road, London, S.W.*

Notices of Books.

"Experimental Chemistry." By Dr. L. C. Newell. Pp. xv. and 410. (London: D. C. Heath.) Illustrated. 5s. Text-books of chemistry are so numerous that a new one is apt to be regarded with the same mixed feelings which the father of a large family receives the news of the advent of another little stranger. But to pursue the analogy, though there is a strong family likeness between the various volumes, each possesses some peculiar characteristics, which may or may not be desirable. The most original feature of Dr. Newell's book is due to the combination of the inductive and deductive methods of teaching. The book contains an enlightened course of practical work as well as a descriptive account of chemical principles and philosophy. It is thus a laboratory manual and a text-book combined; and we know of few books in which the combination is more successfully performed. Usually the experiments described in class-room books are suitable only for the purpose of lecture demonstration, but in the present volume they are of the simple character required for individual work in the laboratory. There are, in addition, practical exercises bearing upon the laboratory work, problems on the calculation of results from given data, and subjects for short descriptive essays. The student who follows such a course of manual and mental work as Dr. Newell provides will derive permanent benefit from it, and the teacher who uses the book will find his work inspired as well as facilitated. The only objection to the wide adoption of the book in this country is the American orthography in such words as "meter," "liter," "color," &c.

"Mammalia" (Cambridge Natural History, Vol. X.). By F. E. Beddard. (London: Macmillan & Co., Ltd.) Pp. xii. and 605. Illustrated. 17s.—In this volume Mr. Beddard has undoubtedly made an important contribution to the history of mammals, his text-book being the only one which can be said to be up to date and to contain notices of the many important types—both recent and fossil—discovered during the last few years. Since the author is an anatomist rather than a systematist, it would be natural to expect that his work should deal with the subject more from the morphological than from the taxonomic aspect, and a glance at the volume will show that this is really the case. Of special importance and interest is the large amount of space devoted to the characters and structure of the brain in the different groups, since this is a subject the author has made specially his own, while it is also one to which but scant attention is generally paid in works of this nature. Another feature worthy of the highest praise is the importance accorded to extinct types, especially since Mr. Beddard is not himself a palæontologist. His morphological studies of the group have, however, evidently led him to conclude that it is quite impossible to arrive at any true conception of the relations of the existing forms without taking into consideration their extinct forerunners. In this part of his subject the author is fortunate in having received much valuable assistance from such a competent authority as Prof. H. F. Osborn, of New York. We have said that Mr. Beddard is not primarily a systematist, nevertheless he is thoroughly up to date, if not indeed in advance of some of his contemporaries, in dividing mammals into two (instead of three) primary groups, namely, into those which lay eggs and those which give birth to living young. In this he is undoubtedly right. Naturally, a large (perhaps disproportionately large) amount of space is allotted to the Cetacea, which have for some years attracted much of the author's attention. In the systematic treatment of some of the other orders, notably the Ungulata, there are, unfortunately, a considerable number of errors and misstatements, which it may be hoped will be remedied in a second edition. In most respects, the work is well worthy of the author, and of the series of which it forms a part.

"Other Worlds: Their Nature, Possibilities, and Habitability in the Light of the Latest Discoveries." By Garrett P. Serviss. (London: Hirschfeld Bros., Limited, 13, Furnival Street, Holborn, E.C. 1902.)—"The point of view of this book is human interest in the other worlds around us." The subject has been often treated, frequently from the standpoint of fiction, less often from that of fact, and Mr. Serviss confines his imagination strictly to the possibilities permitted by facts when discussing the interesting probabilities and theories that have commanded wide popular attention. And we would like to make mention here of the charm and lucidity of Mr. Serviss's style; so simple and clear is the expression of his idea, that we almost lose sight of the depth and science of matters he treats of. On the road from one of our sister planets to another, with his guide book in hand, the wayfaring man though a fool may not err therein. His premisses for habitability may be very briefly described as follows: When the earth cooled and solidified out of the primeval nebula, there lay between the huge inert globe of permanently combined elements below and the equally unchanging realm of ether above, a thin shell (the surface of the crust of the earth, the lower and denser strata of the atmosphere, and the film of water that constitutes the oceans) whereon took place ceaseless combinations and re-combinations of chemical elements in unstable and temporary union, and in this shell life appeared, and only in this shell do we know of life's existence. Air and water furnish the means for the continual transformations by which the bodies of plants and animals are built up and afterwards disintegrated, and we are compelled to regard such a shell as we have on the earth, and containing air and water, or their analogues, as pre-requisites to the existence on any planet of organic life; and Mr. Serviss also includes the active stimulus of sunshine. Judging by this standard, the only habitable globes beside the earth are Venus and Mars; Mercury is in the last degree doubtful as a fit place for habitation; the moon is certainly past use; and the asteroids were never habitable; and Jupiter, Saturn, Uranus, and Neptune are not yet out of the builder's hands, so to speak. Of the satellites of these four outer planets we do not know enough to say one way or the other. The sun is not discussed; its temperature has risen above the destructive point, beyond which our experience teaches us that no organic life can exist. But "habitable" is not synonymous with "inhabited," and Mr. Serviss wisely leaves on one side the question of the nature and form of the inhabitants of other worlds, if such exist. In only one little whimsical sketch, called "A Waif of Space," does he give free rein to his imagination and describe a giant denizen of the minor planet Menippe. It is perhaps not quite fair to object to the description as "not necessarily being true to life" of an individual that he has expressly told us can have no veritable existence, but we think that he is generalising rashly when he describes the aforesaid individual as being three-quarters of a mile high. As we have said before, we can only know and study the laws of life on this earth, an oblate spheroid whose equatorial diameter is about 7926 miles, and whose polar is 7899. Now it would never enter our heads to attempt to deduce the latitude of a man's home from his height; we are very far indeed from finding that the sons of Anak congregate round the pole; nay, we cannot find that anywhere is the scale of men influenced by the locality. In equatorial Africa two races live side by side, and the average height of one is almost double the average height of the other, that is to say, the bulk of the giant man is some eight times the bulk of the pigmy. Had we half-a-dozen worlds to study, and the means of making a comparison of the scales on which all their elephants, and all their men, and all their ants are built, we might find some law connecting them with the diameter of their world, but as it is, with but one poor earth to reason from, there is not enough evidence to go before a jury. Having described the probable physical conditions of the planets, Mr. Serviss concludes his book by a very useful chapter on "How to find the Planets," which is illustrated by charts showing naked-eye stars near which the planets may pass in their course round the ecliptic.

"Circular No. 9 of the Astrographic Conference."—A considerable amount of literature is gathering round the work of the Astrographic Chart and Catalogue; the present Memoir is chiefly from the pen of M. Loewy and is for the purpose of establishing the true correlation that exists between the relative positions of the stellar images on the plates, and of the corresponding stars in the sky. In the course of the investigation the following points have become evident:—In every plate, whatever its diversity of exposure, the two feeblest magnitudes of stars photographed only correspond imperfectly, both in brightness and position, with the corresponding celestial objects. The error of position is more notable than that which results from the operation of measuring, and is due to the imperfect sensibility of the gelatine to the feeblest beams of light. Star trails do not give rise to any special error, but the source of uncertainty mentioned above holds good for the faintest trails just as for the faintest star discs. When the images of a multiple exposure lie along a co-ordinate, the errors affecting the other co-ordinate are much more notable than for that passing through the line of images. The accuracy of the measures of the second co-ordinate is not increased by utilising more images. From the point of view of precision the weight to be attached to measures along the first co-ordinate is double that of the second. To render the precision of the measures homogeneous in the two co-ordinates, the line joining the stellar discs of a multiple exposure should bisect the angle between the co-ordinates. M. Loewy is also of opinion that the elongation of the images towards the borders of the plate does not affect the accuracy of their measurement, at least in stars above the limit of sensibility on the plate. In the preface, M. Loewy refutes the argument of Mr. Plummer and Mr. Hinks that systematic errors will be eliminated if the plates are measured in two positions differing by an angle of 180°. A notable systematic error is evident if the measures be compared which are taken in positions of the plate at $\frac{0^\circ+180^\circ}{2}$ and $\frac{0^\circ+270^\circ}{2}$ as he shows in the third Memoir of the present Circular.

"Occultations of Stars and Solar Eclipses." By F. C. Penrose. Second Edition. (London: Macmillan & Co., Ltd. 1902).—The first edition of Mr. Penrose's most valuable work appeared in 1869, and in the present issue the work has been much condensed and simplified as well as partially extended, especially in the case of total solar eclipses. Thus the conditions of totality for the total solar eclipse of January 22, 1898, as seen at Sahdol, in India, is one of the new diagrams.

BOOKS RECEIVED.

Dictionary of Photography. By E. J. Wall, F.R.P.S. (Hazell, Watson & Viney.) Illustrated. 7s. 6d net.

Gentle Art of Book Lending. By George Somes Layard. (Malvern Federated Library.)

First Stage Mathematics (Organised Science Series). Edited by William Briggs. (University Tutorial Press.) 2s.

Year Book of Photography and Amateurs' Guide, 1902. (*Photographic News* Office.) 1s net.

Plant Physiology. By William F. Ganong, PH.D. (Bell.) Illustrated. 5s. net.

Injurious and Useful Insects. By L. C. Miall, F.R.S. (Bell.) Illustrated. 3s. 6d.

Metallography. By Arthur H. Hiorns. (Macmillan.) Illustrated. 6s.

Studies in Heterogenesis. Second Part. By H. Charlton Bastian, M.A., M.D., F.R.S. (Williams & Norgate.) Illustrated. 7s. 6d.

Watkins' Manual of Exposure and Development. By Alfred Watkins. (Houghton.) 1s. net.

Bulletins of the University of Kansas. Vol. IX., Nos. 1, 2, 3, 4, and Vol. X., Nos. 1, 2, 3. (Kansas University.)

Chaldean Astrology Up to Date. By George Wilde. (Marsh-Stiles.) 7s. 6d.

Mining in Rhodesia. (British South Africa Company.)

Meteorological Observations for 1901. (Rousdon Observatory.)

Zoological Gardens, Ghizeh, near Cairo: Report for the Year 1901. By Stanley S. Flower. (Cairo: National Printing Department.)

Process Photogram. July, 1902. 6d.

New Phytologist. Vol. I., No. 6. 1s. 6d.

Preparation of the Earth for Man's Abode By J. Logan Lobley, F.G.S., F.R.G.S. (Victoria Institute Transactions.)

Scientific Roll. By Alexander Ramsay. (R. L Sharland.) 1s.

Memorias y Revista de la Sociedad Científica "Antonio Alzate." XIII., Nos. 3 and 4; XVI., Nos. 2 and 3.

Catalogue of Max Kohl, Chemnitz. (Isenthal & Co., sole agents for the United Kingdom and its colonies.)

Abridged Catalogue, 1902. (Ross, Limited, 111, New Bond Street.)

Catalogue of Photographic Apparatus. (Sanders & Crowhurst, 71, Shaftesbury Avenue.)

Catalogue No. 2. "Philosophical Apparatus." (Newton & Co.)

THE NOBODIES,—A SEA-FARING FAMILY.

By the Rev. T. R. R. Stebbing, M.A., F.R.S., V.P.L.S., F.Z.S.

CHAPTER IV.

If the Pycnogonida have, comparatively speaking, no bodies and with an inconsiderate world no flaunting reputation, they are by this time fully freed from the hardship of having no names. With these they have been abundantly blessed, though, when the names are attended by definitions that leave them altogether indefinite, the blessing is very much in disguise. More than forty genera have been nominally established, but some of them so obscurely that now and then a desperate author pounds up eight or nine into one. Then again the counsels of despair have to be modified, and some of the rejected names resume their place in the system.

There is, as naturalists are aware, a continual strife being waged over classification. The philosopher is here at one with the many. He desires and demands the natural, the best, the permanent. The working zoologist supplies only the imperfect and the transitory, based on a disgraceful neglect of all those features and conditions which at the time he happens to know nothing about. His patient toil, his gradual acquisition of knowledge and insight, bring him into more discredit. For he changes his system to embrace the new facts, and with his old perversity does not include in it the unknown and the unsuspected. The history of the Pycnogonida is instructive as showing that "all the talents," though they may include industry, perspicacity, imagination, genius, are incapable of producing a perfect classification until the globe has been ransacked for materials and until the materials themselves have been ransacked for informing guidance.

It has been already noted that the Pycnogonida are exclusively marine. An exception might be suspected in *Pallenopsis fluminensis* (Kröyer), which owes its specific name to the word Rio, a river, but Kröyer, who gave the name, explicitly states that the species was taken in the sea, in the nautical roadstead of Rio Janeiro. Future researches may find isolated members of the group living in fresh water or on dry land, but in the meantime the waters of the ocean, with their depths and shallows, straits and inlets, and the space between tide-marks along the curves and indentures of an almost immeasurable coast-line, offer a hunting-ground not likely to be soon exhausted. In particular localities of this vast field some species are said to be common or very abundant. Some species are widely distributed. Speaking of them as a group Dr. Dohrn says that "they belong to the most frequent animal forms included in the shore-fauna of all seas: you can scarcely examine a handful of sea-weeds, a few fragments of submarine gravel, or materials from the hauling of a dredge, without lighting upon one or more species of these little creatures." Still, as a rule, they seem to be a feeble and scattered folk, and yet, though their numbers are relatively few, they easily fall into the hands of the collector. An explanation of this may be suggested. In spite of their long legs they have no speed of motion, nor do they, like many children of the sea, practise varied tricks of evasiveness. Interference will induce them to crumple up their many-jointed limbs, but will not provoke them to show fight, for which they are poorly endowed. One may infer from all this that their enemies are not numerous or pertinacious. Man has been neglectful. Other devourers may have found by experience that there was no satisfactory nutriment in their long branching tubes of chitinous, or as Eights calls it "pergamineous" integument. They won't fatten. Nevertheless, like other animals, they have obeyed some stimulus impelling them to vary. Assuming that all are traceable to a common ancestor, we may ask which of the existing species are nearest to the original form, or which are the most remote from it. As so often happens in genealogies, there is a deplorable want of trustworthy documents. Fossils at present give no assistance. The larval stages cannot be expected to speak with other than a lisping voice. Existing species must be compared and cross-examined, and even then the antiquity of common characters is rendered uncertain by the chance that some may have been independently developed more than once, or have come again into evidence after a period of disappearance.

If we are searching not for the most but for the least characteristic genus, some authors not unreasonably direct our attention to *Pycnogonum*. It was a singular fate which brought this first into scientific notice, gave to this first a technically valid name and thus made it the premier genus of the group. For instead of being a good representative, it appears to have gathered about it as many exceptional attributes as it could. Most of the Pycnogonida have very slender bodies and very long legs. *Pycnogonum* delights to have the body stout and the legs rather stumpy. All the other genera find space within the body for a heart. *Pycnogonum*, in which the body is more than usually roomy, goes without one. Commonly the eggs when laid are divided between the two ovigerous legs of the male; in *Pycnogonum* both these legs are used for carrying a single egg-clump. The normal complement of limbs in the Pycnogonida, as we have seen, is seven pairs; *Pycnogonum* belongs to the anomalous section which exhibits only five pairs in the male and no more than four in the female. It has been heretofore explained how this genus flies in the face of custom by having no genital openings in the second joint of any but the last pair of legs, and there it has them sometimes contrary to usage in the upper instead of the lower surface of the joint. It goes further, and conspires with one other genus, Dohrn's *Barana*, to flout the speciality of its tribe by developing ova not only along the legs but also in the body.

Pycnogonum littorale (Ström) ♀. From Sars.

It might be argued that the characters displayed in *Pycnogonum* are primitive, and that the contrasted genera have in these respects departed from the earlier type. It is almost certain, for instance, that, before the expedient of developing ova in the legs came into play, the normal method of developing them in the body will have been followed by many an ancestress of the tribe. On the other hand that normal method may have fallen into disuse and after a long interval been revived. That the genital openings were originally a single pair is at least conceivable, but again it would not follow that the singleness in *Pycnogonum* must be regarded as original. To believe that females without the first three pairs of appendages are of an earlier type than those which have them would require a very robust faith. It would imply that the ovigerous function of the third pair in the males was primitive, whereas it is much more likely that this function was transferred from the females, and that the egg-bearing sex suffered loss of the egg-carrying limbs owing to disuse. Still more decisively is the view that *Pycnogonum* has had losses rather than that the other genera have had gains, supported by the facts connected with the first pair of appendages. These are wanting in adults of both sexes not only of *Pycnogonum* but of various other genera, and in many are found to be small and rudimentary. But, as explained in the preceding chapter, the larval forms all have these appendages, and, more than that, they all have them chelate. It would be difficult, therefore, to resist the inference that this pair at least is an original part of the organism. The circumstance that in some instances it dwindles and loses its chelate character in the adult, without disappearing altogether, gave rise to a very natural mistake. A genus *Ammothea* was founded by Leach on the young, and subsequently a genus *Achelia* by Hodge on the full-grown specimens of congeneric species, and these two genera, which are really one and the same genus, were even recently and by an approved author placed in separate families. It is no reproach to the systematist that he should fall into such errors while feeling his way towards a natural classification. The hand of man is a structure to which the human race is so incalculably indebted for its elevation above all other animals that, if a tribe were discovered in which each arm ended in a solid stump instead of fingers, there would no doubt be little temptation to consider it human. Yet, if it proved that the infants had thumbs and fingers like our own, it might be equally difficult to classify the offspring apart from ourselves or the parents apart from their offspring. But the young *Ammothea* is just in this position. To begin

Ammothea magnirostris, Dohrn. ♂. Only basal joints shown of hinder legs. From Dohrn.

with it possesses the grasping chelæ stretched in front of its mouth. Then, with advancing life it sacrifices this advantage, first allowing the claws to occupy a seemingly quite ineffective situation to the rear of the mouth, and

Ammothea magnirostris, Dohrn. Minute larva greatly magnified. From Dohrn.

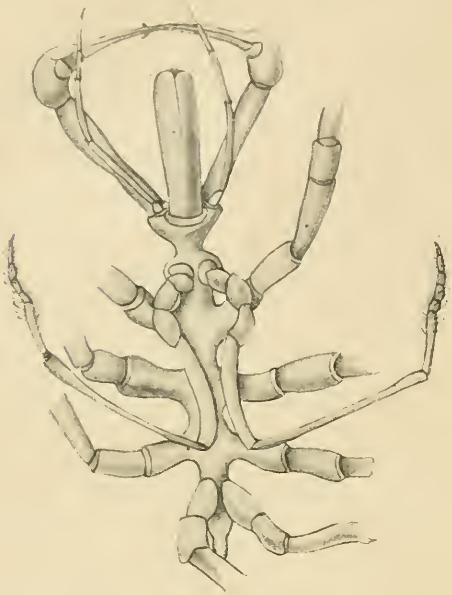
finally relinquishing their chelate character which in such a situation had ceased to be of value.

So fundamental is the importance of the chelate first appendages in the opinion of Professor G. O. Sars, that upon them he bases the primary division of the whole group into three orders or sections. Leach in earlier days on the same principle bisected it into the Gnathonia and Agnathonia. Fuller knowledge now requires a tripartite arrangement. Thus the Achelata are entirely without "chelifori" except in the larval condition. The Euchelata retain them throughout life. The Cryptochelata have them in the larval and young stages of their existence, but as adults lose them altogether or keep them only in a rudimentary state. To the first section Sars assigns two families, and three to each of the others. The Achelata comprise the Pycnogonidæ and the Chilophoxidæ, each with a single genus, and both agreeing in the absence not only of the first appendages but also of the second, the female sex wanting the third likewise. They differ because *Pycnogonum*, the representative of the first family, stands almost alone in the restricted number of the genital openings. *Chilophoxus*, for which the second family is instituted, has these apertures in all the ambulatory legs of the female and in the last three pairs of the male.* Moreover, while *Pycnogonum* has a certain portliness, which gives its typical species a claim to be somebody among nobodies just as the one-eyed man is a king among the blind, *Chilophoxus* on the contrary has nothing to show but attenuated personalities. The typical species of this latter genus is among the earlier known forms, having been described by Montagu in a paper which was read at the Linnean Society in 1805 and published in 1808. Montagu was under the impression, shared as we know by many distinguished naturalists long after him, that the ovigerous legs belonged to the female. He correctly describes the position of the four eyes on their conical tubercle, but adds that they "appear under a microscope strongly reticulated." This would seem to have been an ocular delusion on his part, for although the modern method of section-cutting has revealed a reticular tissue within the eye, such an observation would have been unattainable by any implements at Colonel Montagu's disposal. He also remarks that "on the back between the hinder pair of legs is an erect cylindric tubercle, which in some point of view might be mistaken for a tail." Tail is an indefinite word or one might wonder where the mistake comes in, for, if the part of the body which follows the ambulatory limbs may indifferently be spoken of as the abdomen or tail in crustaceans, insects, and scorpions, those expressions will be equally appropriate for the cylindric tubercle of which Montagu is speaking.

Not without some fear of evoking those electric flashes that are ever ready to smite the rash disturbers of long accepted terminology, I must here invite the special attention of naturalists to the new names *Chilophoxus* and Chilophoxidæ, and to the cancelling of the names Pallenidæ and *Pseudopallene* in favour respectively of Phoxichilidæ and *Phoxichilus*. This last-named genus was instituted by Latreille in the "Nouveau Dictionnaire d'Histoire Naturelle," tom. 24, p. 137, so far back as 1804, not as has been stated in 1816. The only species assigned to it was the *Pycnogonum spinipes* of O. Fabricius. It is impossible therefore to retain *Phoxichilus* apart from that species. Consequently *Pseudopallene*, Wilson, 1878, to which both Sars and Meinert refer the above-named *P. spinipes* of the "Fauna Groenlandica," becomes a synonym of Latreille's far earlier genus, and the family hitherto known as Pallenidæ, from *Pallene*, Goodsir, 1837, must be henceforward known as Phoxichilidæ. All species which have been assigned to *Phoxichilus* on the ground of a real generic agreement with Montagu's *Phalangium spinosum* must now be transferred along with this species to *Chilophoxus*, while *Pseudopallene circularis* (Goodsir) will find its place in the true *Phoxichilus* as now reinstated.

* Mr. Marshall's paper "On variation in the number and arrangement of the male genital apertures in the Norway Lobster" (*Proc. Zool. Soc. London*, 1902), is worth considering in connection with our subject, but with the crustacean it is an increase in the number of openings that is exceptional, whereas in the Pycnogonida it is the diminution in their number that calls for remark.

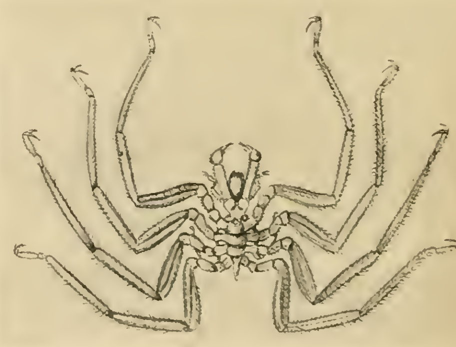
The Euchelata comprise three families which all have the first appendages well developed but vary in regard to the second. These are wanting in the Phoxichilidiidæ, small or rudimentary in the Phoxichilidæ, and only five-to-seven-jointed in the Nymphonidae. The first of these families has a further link with the preceding section in that the females are without the ovigerous legs. Among other genera it contains one to which the eccentric French naturalist Eugène Hesse applied the name *Oomerus*, meaning "eggs in the thighs." As Goldsmith said of Edmund Burke that he "gave to a party what was meant for mankind," so here the French writer allots to a single genus a term that fits all the Pycnogonida. Very probably his ill-defined genus is not distinct from the earlier *Phoxichilidium*, Milne-Edwards, 1840, from which Wilson, in 1878, separated *Anoplodactylus*, itself perhaps identical with *Anaphia*, Say, 1821. In *Phoxichilidium* the peculiarity has been noticed that the young become parasitic on zoophytes. *Anoplodactylus* by its name, meaning "unarmed finger," alludes to a supposed contrast between this genus and that from which it was detached. The ambulatory legs in *Phoxichilidium* have a powerful finger or claw, on the back of which close to the base are a pair of auxiliary claws, small but conspicuous. A species which seemed to be without these accessories was on that account transferred to *Anoplodactylus*, but now in turn Sars has shown that the auxiliary claws are actually present in the new genus as well as the old, though so small and feeble as scarcely to deserve the title of weapons.



Nymphon hamatum, Hoek, ♂. Ventral view, legs only partially shown. From Hoek.

Of the Phoxichilidiidæ some illustrations have been given in earlier chapters. To it belong, in addition to genera already mentioned, *Pseudopallene*, Wilson, 1878, *Hannonia*, Hoek, 1881, *Neopallene*, Dohrn, 1881, *Cordylochele*, Sars, 1888, and *Parapallene*, Carpenter, 1892.

The Nymphonidæ are interesting in various ways. As already explained, *Nymphon marinum* (Ström) is the earliest recorded species. *Nymphon*, Fabricius, 1794, is the earliest genus but one, and includes a greater number of species than any of the other genera. Some of the forms comprised in it, though not actually the largest, are among the largest known. With one exception, representatives of it reach the greatest depths in the ocean attained by any of this group, descending a long way below two thousand fathoms, so as to be separated from the upper air by a thickness of two and a half miles of water. The species figured was dredged up from one thousand six hundred fathoms in the Southern Ocean. Ström's *N. marinum* is one of six species of the genus found in British waters. This was re-described by Harry Goodsir in 1845 as *N. giganteum*, from Northumberland. He gives the span of it as six inches, equivalent to one hundred and fifty millimetres. Other authorities give the length of the body as three-fifths of an inch or fifteen millimetres, so that the legs are nearly five times as long as the body. But that this giant is not very corpulent is shown by a further minute calculation which Kröyer supplies. He reckons that the legs are about sixty times as long as the breadth of their fourth joint, which no doubt he chooses as being the limb's broadest part Till recently a seventh British species of this genus might have been counted, but Goodsir's *N. spinosum* has now been transferred by Sars to a new genus *Chætonymphon*, "the hairy Nymphon." This designation alludes to a characteristic which had been noted in three species, respectively named on that account *hirtum*, *hirtipes*, and *spinosum* (shaggy, shaggy-foot, and thorny), by Fabricius, Bell, and Goodsir. Besides five northern species this genus contains one from the chill southern waters of Kerguelen Island. The hairiness of this sub-antarctic form is attested by the name *hispidum* given it by Hoek in 1881, and by the earlier *horridum* given it by Böhm in 1879. But, let the species be as rugged as a bear, as bristly as the fretful porcupine, it cannot retain either of these names, for it has proved to be an acquisition made by the Antarctic Expedition under Sir James Ross when, visiting Kerguelen in May and June, 1840, an acquisition



Chætonymphon spinosum (Goodsir)♀. After Sars.

which had lain in our national collection unnamed and unregarded until a preliminary description of it as *Nymphon brevicaudatum* was published by Miers in 1875. For the Arctic species named by Bell *Nymphon robustum*, Sars has founded the genus *Boreonymphon*, "the boreal

Nymphon." This may apparently be considered as just coming within the British area of marine zoology, since on the cruise of the "Knight Errant" it was taken at a great depth to the north of Scotland but as far south as latitude 60°. Sir John Murray, of the "Challenger," writing to Dr. Hoek, informed him that the immense number of specimens of this species obtained on that occasion was the largest haul of Pycnogonida he had ever seen—about a thousand specimens. Sars, when explaining his motive for instituting the genus, observes, "the peculiar circumstance that the young continue to remain firmly adherent to the body of the male, even after they have attained more than half the definite size, is also remarked among the generic characters, as a similar relation, so far as I am aware, has not been found in any other Pycnogonid." Another genus, *Paranymphon*, with seven joints instead of five to the second appendages, was founded by Caullery in 1896 for a species from considerable depths in the Bay of Biscay. The same species has since been found also in high northern latitudes. Like *Boreonymphon robustum* it is blind.

The genus *Decolopoda*, Eights, 1837, requires either an additional family Decolopodidæ, or a widening of the definition of the Nymphonidæ, for its second pair of appendages are ten-jointed. The typical species *D. australis* was taken in the vicinity of the New South-Shetland Islands. Its chelifori are large with much curved thumb and finger. Of the many specimens obtained all were provided with ovigerous limbs, eleven-jointed, so that Eights counted these in with the four following pairs of legs, and framed a generic name which signifies that in this form there are "ten perfect feet." "The entire animal," he says, "is of a bright scarlet." With this gay picture to contemplate, we may conveniently pause before attempting a survey of the Cryptochelata.

Conducted by M. I. Cross.

Pond-life Collecting in August.—For the collector of Cyclops, Diaptomus, Waterfleas, and aquatic insect larvæ, August is a very capital month; not so, however, for the collector of the more interesting Infusoria and Rotifera, which are usually quite crowded out by the more vigorous crustaceans in the few remaining ponds and pools not wholly dried up. In larger lakes, however, it is possible to find occasionally a number of interesting forms, particularly free-swimming Rotifers such as *Asplanchna priodonta* and *brightwelli*, *Synchæta pectinata* and the rarer summer forms: *Synchæta stylata* and *grandis*. Where a "green" pond can be found, full of the flagellate Infusorian *Euglena viridis*, there are usually present also a number of Rotifers such as *Hydatina senta*, *Eosphora aurita*, *Diglena biraphis*, etc., feeding on the Euglena.

In shady forest pools, overgrown with Sphagnum, quite a peculiar fauna of Moss-haunting Rotifers will be found, particularly various species of *Callidina*, *Distyla*, *Metopidia*, *Cathypna*, in addition to numerous interesting Rhizopods with shells of various forms. In similar ponds the large, but very rare, Rotifer *Copeus spicatus* should be looked for. Of other Rotifers that may be met with in lakes, more or less abundantly, the following can be mentioned: *Brachionus pala*; *Anuræa aculeata*, *brevispina* and *hypelasma*; *Dinocharis pocillum*; *Euchlanis triquetra*, *hyalina* and *oropha*; *Mastigocerca bicornis*, *elongata* and *stylata*; *Polyarthra platyptera*; *Synchaeta tremula* and *oblonga*; *Pedalion mirum*; and many others.

Apochromatism and other Terms.—So much confusion seems to exist, even at this day, as to what is understood by the term "apochromatism," that it may be well to express, in as intelligible a form as possible, the essential qualities which are properly associated with this name, and the difference that exists between it and semi-apochromatism and achromatism.

Apochromatism is an expression of the highest attainable correction of microscope objectives, comprising the correction of spherical aberration for all colours and the union of three different colours in one focus, that is, elimination of the secondary spectrum.

Semi-apochromatism may be defined as combining such qualities that the spherical aberration is corrected practically for all colours. It will be understood that in this case the secondary spectrum is present.

An *achromatic* microscope objective, pure and simple, is one in which, as a rule, defects worse than the secondary spectrum are caused by spherical aberration of the coloured rays, the spherical aberration being corrected for the brightest part of the spectrum only. Generally in this correction two different colours only are united in the same focal point.

In order that a clear conception may be formed of the above remarks, it will be well to append a brief explanation of the *Secondary Spectrum*. In an achromatic lens the chromatic aberration is corrected for the brightest (yellow and green) rays of the spectrum, and the pronounced colour shown by uncorrected lenses is, in consequence, removed.

A stricter examination, however, shows that rays of a different colour are not brought to the same focus, for, owing to the fact that flint glass, as compared with crown glass, disperses the more refrangible rays relatively too much, and the least refrangible relatively too little, a peculiar *secondary* spectrum results from the achromatic combination, the rays corresponding to the brightest apple-green part of the ordinary spectrum being very closely united and focussed nearest the combination, whilst the other colours focus at increasing distances *in pairs*, yellow being united with dark green, orange with blue, red with indigo. The composite effect of these colours is best seen with oblique light, causing dark objects to have apple-green borders on one side and purple ones on the other.

Preparation of Metal Specimens for the Microscope.—In Knowledge for November, 1901, reference was made to the microscopic examination of metals in general terms, and as some considerable interest was evinced in the subject, the following notes have been prepared to guide those who may wish to experiment for themselves in the preparation of metal specimens for examination.

The preparation of specimens of metal for the microscope involves the greatest care; the principal object being to obtain a perfectly level surface, free from all scratches and marks, with the highest degree of polish. This will be better illustrated by an example.

The student having obtained a sample of metal, the first thing to do is to carefully file or grind the surfaces he wishes to examine. The marks thus made must be taken out with a very smooth file or emery cloth, gradually diminishing the coarseness of the cloth until he reaches the finest grade of all.

From this stage the polishing must be done on parchment or chamois leather stretched very tightly on wood: the leather being covered with fine crocus powder or rouge moistened with a little water.

This is the most important stage of the specimen, especially if the metal be very soft, and the student should frequently examine the metal through the microscope—a matter of a few moments only—by clamping it in one of the new metal holders which have been recently introduced by Messrs. R. & J. Beck and Watson & Sons. These holders are fitted with jaws in which the subject is firmly gripped, and provide for setting in any plane, and obviate the necessity for mounting the specimens on glass slips.

On examination it will be seen that parts stand in very high relief. This is the object of the leather polishing—to gradually grind away the soft and leave the hard parts, and great care should be exercised.

Having obtained the requisite degree of polish the specimen is now ready for further treatment, viz.: etching. The object of this is to further develop the structure.

Etching is done by means of various reagents, the choice of which is mainly a matter of personal opinion, but perhaps the most generally used, and the best for beginners, are infusion of liquorice root and tincture of iodine. Very dilute nitric acid and sulphuric acid are also used, but until the student has become thoroughly acquainted with the effects of the above he is not advised to use them.

Before proceeding further it is advisable to give an outline respecting the effects of the reagents, also the construction of the metal.

Steel is viewed as if it were a rock with various constituents in it. There are three principal ones, viz.: Ferrite, Cementite, and Pearlite (or Sorbite).

Ferrite:—This is free from carbon: it retains a very dull polish, and is not stained by iodine or liquorice. To develop the crystalline structure of Ferrite, a very dilute solution of nitric acid in alcohol should be used.

Cementite:—This is a very hard substance, and stands in relief after polishing as above. It is very rarely found in low-carbon steels, and is left bright after the polished surface is attacked by iodine.

Pearlite:—This is a very intimate mixture of Ferrite and Cementite. If the steel has been allowed to cool slowly from a very high temperature, Pearlite assumes a well-defined lamellar structure; on the contrary, if the metal has been forged, or re-heated at a very low temperature, Pearlite assumes a granular appearance. It is readily acted upon by iodine or liquorice.

From this it will be seen that steel is made up of: (1) Ferrite and Pearlite, (2) Pearlite, (3) of Pearlite and Cementite. Other constituents are found in steel after it has undergone certain treatment, but enough has been said to guide the student to make a commencement.

The method of applying the reagent is as follows:—The specimen is either coated with some protective varnish—leaving the surface free that is to be acted upon—and immersing the whole in a bath; or a few drops may be applied to the surface, and then carefully spread by means of a glass dipping rod. The solution should be allowed to act, say, for twenty seconds, then carefully washed in alcohol or methylated spirits, gently rubbing the surface with the little finger, finally washing in water, and drying with a very soft piece of linen.

The metal is now examined under the microscope, and it will then be seen if the etching has been sufficient; if not, it should be repeated as above for another twenty seconds. The student should do this several times, noting the effect of the reagent each time until he becomes thoroughly acquainted with its properties.

So far we have only dealt with steel, but alloys of tin, copper, &c., are treated in exactly the same way, with the exception that liquorice and iodine are not used. The various acids, ammonia and caustic potash, &c., are used in weak solutions as etching reagents.

With respect to the mounting of the specimens, from what has already been said regarding the new holders, it will be seen that the affixing to glass slides is no longer necessary. Where a glass slide is used a great deal of extra work is involved, because it sometimes happens that the under side of the metal is left jagged, or may be broken off at a very sharp angle, and before this could be mounted there would be a long delay in filing and grinding, also the thickness of the block of metal would have to be kept within certain limits. No consideration has to be paid to these matters when a holder is used.

Some workers bed the metal on a glass slide in modeller's wax, and then to render it quite plane attach to the microscope nose-piece an uprighting tool and bring it down on the face of the metal under examination. It will be at once seen that all this is really not needful with a clamping holder.

NOTES AND QUERIES.

Sigma.—A glycerine immersion objective cannot be so efficient as the homogeneous one, or that which is used with cedar wood oil. Glycerine has not a refractive index the same as crown glass, being only 1·47, and its dispersion is too high; moreover, its hygroscopic properties are against it. It has been practically abandoned since the superiority of cedar wood oil has been established. An air-angle of 170° would correspond to a N.A. of ·995, which is very low for an immersion lens.

J. Hills.—Presumably you wish to know the best way to keep insects that you may collect for future mounting as micro objects. If so, you cannot do better than place those with hard chitonous bodies in methylated spirit, the more delicate ones might be more satisfactorily preserved in spirit and water, half of each.

Note.—The Centipedes from Portugal which were offered for distribution in the June number have been identified as *Scutigera coleoptoata*, and are stated to be very fine specimens. A few of these are yet available on receipt of a stamped label and a glass collecting tube.

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.

Jean Louis Pons, who began his comet-seeking about a century ago, must still be regarded as the most successful worker who has ever entered this field. He was born in 1761, and died in 1831. When doorkeeper at the Observatory of Marseilles he was instructed and encouraged by the Director, Thulis (the discoverer of Encke's comet at its return in 1805), to take up the search for new comets, and Pons followed the work so successfully during the 26 years from 1801, July 12, to 1827, August 26, that he independently discovered 37 comets. In several instances he was, however, anticipated by other observers, though the fact remains that during the first quarter of the 19th century he discovered nearly all the comets that were seen. During the 14 years he remained at Marseilles he picked up 18 new comets. His initial success was in 1801, July 12, but several other astronomers, including Messier, Mechain, and Bouvard, shared this discovery. It was just a century ago, namely, on 1802, August 26, that Pons could claim to have been absolutely the first discoverer of a comet. Among the more important objects he found may be mentioned the periodical comets of Biela (1805), and of Encke and Winnecke (1819). In 1812 he picked up a comet which proved to have a period of about 71 years, and belonged to the Neptune family. Pons supplied a prominent example of an individual entirely devoting himself, with an ability only matched by his diligence, to one field of observation and achieving success beyond any historical parallel, either before or after his time.

Comet 1898 I. (Perrine).—A definitive determination of the orbit of this comet has been made by Heber D. Curtis, of Virginia. In all the comet was observed 666 times for position, and 34 different observatories participated in the work. The comet remained visible during about eight months (March 20th to November 15th), and an especially fine series of observations were secured by the discoverer, Mr. C. D. Perrine, with the 12 and 36-inch equatorials of the Lick Observatory on Mount Hamilton. From the visual estimates of the diameter of the coma, ranging from 2 minutes of arc on the date of discovery to 10 seconds of arc at the middle of November, there seems to have occurred a considerable shrinkage, the dimensions at the two periods being 84,000 miles and 12,000 miles, while the distances of the comet from the earth were 147 and 247 millions of miles respectively. The following are the definitive elements:—

Equinox of 1898·0.

P.P. = 1898 March 17·130777 G.M.T.

$\omega = 47° 19' 11''.85.$

$\Omega = 262° 26' 19''.06.$

$i = 72° 31' 47''.01.$

$\log. q = 0·0395112.$

$e = 0·9803852.$

Period $= 417·2 \pm 2·2$ years.

August Perseids.—During the first half of August, moonlight will offer little impediment to the visible progress of the display, and, with clear weather, it will be possible to obtain an unusually successful series of observations. There are several points in connection with this rich annual shower which require further investigation, viz.: the horary number of meteors visible, the exact position of the radiant on each night of observation, and the character of the radiation (*i.e.*, whether limited to a contracted area or diffused over a comparatively large space). Observers will also do well to record the times and apparent courses of the brighter meteors seen (especially such as are non-Perseids) so that data may be available for computing their real paths in the air. As 1900 was not leap-year the maximum number of meteors will appear on the morning of August 12 or 13. An ephemeris of the radiant, based on a large number of observations obtained in previous years, will be found in the *Monthly Notices* for December, 1901, p. 169.

Fireball at Noonday.—An observer, writing from York, says that he was amongst the Wolds on June 28th, and at 11h. 48m. a.m. saw a large meteorite travelling rapidly from east to north-east, and falling from an altitude of 40 to 20 degrees. The sun was shining in a sky almost entirely free from cloud. The meteorite exhibited a rounded head and a tail of vivid phosphorescent green colour, and it formed a conspicuous object on the deep blue of the firmament. Another observer, residing at Driffield, noticed the phenomenon, and describes it as moving from the east some distance above the horizon, and looking like polished silver.

THE FACE OF THE SKY FOR AUGUST.

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

The Sun.—On the 1st the sun rises at 4.24 A.M., and sets at 7.48 P.M. On the 31st he rises at 5.11 A.M., and sets at 6.49 P.M.

There is a lack of sunspots and faculæ, and indeed there is every prospect of this year, like the last, being one of an abnormal minimum.

The Moon:—

	Phases.	h. m.
Aug. 3	● New Moon	8 17 P.M.
,, 11	☽ First Quarter	4 24 A.M.
,, 19	○ Full Moon	6 3 A.M.
,, 26	☾ Last Quarter	11 4 A.M.

The Moon is in perigee on the 1st and 29th, and in apogee on the 13th.

Occultations.—On the 10th, the bright star α Librae will suffer occultation. The following are the particulars:—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Aug. 10	α^1 Librae	5·3	8 29 P.M.	132	106	9 32 P.M.	250	217	7 0
,, 10	α^2 Librae	3·0	8 41 P.M.	142	114	9 35 P.M.	239	206	7 0

The Planets.—Mercury is not observable, being in superior conjunction with the sun on the 11th.

Venus is a morning star, in Gemini, and is near Mars on the 1st. The planet rises in the N.E. about $2\frac{1}{2}$ hours prior to the sun; the apparent diameter is shrinking, being now only 12″·0, whilst 0·89 of her disc is illuminated.

Mars is a morning star in Gemini. He rises in the N.E. about 1.30 A.M. The distance of the planet is so great, however, that the apparent diameter is only 4″·0, and his disc is somewhat gibbous, 0·96 being illuminated.

Jupiter is now visible from sunset to sunrise, and attracts the attention immediately on looking to the south, not very high up in the sky. About the middle of the month he is on the meridian at 11.20 P.M., whilst on the 5th the planet is in opposition to the sun, and then attains his greatest apparent diameter of 45″·0. During the month he describes a retrograde path, passing so close to θ Capricorni that the star should be seen in the same field of view as the planet on the evening of the 4th.

Observing at 11 P.M., three satellites only will be visible on the 4th, 6th, 19th, 22nd, 27th, and 29th, the other being either in transit, eclipse, or occultation, whilst on the 12th two satellites will be eclipsed, satellites II. and IV. being visible.

Saturn is in Sagittarius, and though somewhat low down is very conveniently situated for observation in the early evening; about the middle of the month he is on the meridian at 10 P.M., thus being some 20° to the west of Jupiter. On the 8th the apparent polar diameter of the planet is 17″·0, whilst the major and minor axes of the ring have diameters of 42″·5 and 16″·6 respectively, the northern surface being invisible.

Uranus is in Ophiuchus, near the star Theta in that constellation; on account of its small altitude it is scarcely discernible to the naked eye, but by the aid of the chart given in the June number, and small optical assistance, it may easily be picked out from amongst the surrounding stars. At the beginning of the month the planet souths at 8.30 P.M., whilst his apparent diameter is 3″·7; on the 27th of the month he is at the stationary point, after which his path is direct or easterly.

Neptune is a morning star in Gemini, but for all ordinary purposes is out of range.

The Stars.—About 9 P.M. at the beginning of the month the constellations to be noticed are:—

Zenith	Lyra (*Vega*), Hercules, Draco.
South	Sagittarius, Scorpio, Ophiuchus, Aquila; Aquarius and Capricornus to the S.E.
West	Boötis, Corona; Great Bear to the N.W., Virgo and Libra, S.W.
East	Cygnus, Delphinus, Pegasus, Aries; Andromeda and Cassiopeia to the N.E.
North	Ursa Minor, Auriga (*Capella* on horizon).

Minima of Algol will occur on the 9th at 0h. 38m. A.M., 11th at 9h. 27m. P.M., and the 31st at 11h. 10m. 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. 7.

The Author's key is 1. Q to R3, but 1. Q to Kt3 and 1. Q to B4 will also solve the Problem.

No. 8.

Key-move.—1. P × P.

If 1. . . . any except K to Q4, 2. Q to B5ch, etc.

[After 1. . . . K to Q4 there is a quintuple continuation by Q to B5ch or Q to B7ch or QK2, or QKsq or R × KP.]

No. 9.

Key-move.—1. Q to Bsq.

If 1. . . . Kt × Q,	2. Kt to B3ch, etc.
1. . . . Kt to Kt5	2. Q to B5ch, etc.
1. . . . P to K4,	2. Q to Q2ch, etc.
1. . . . K × R,	2. Q × Pch, etc.
1. . . . B to Q6 or P × P,	2. B to K6ch, etc.
1. . . . B to B5 or Q8,	2. Q mates.
1. . . . Any other,	2. Q × P, etc.

[There are duals after 1. . . . P to Kt4, by 2. Q × P or Q to B5ch; after 1. . . . B to Q6, by 2. Kt × Pch or B to K6ch; and after 1. . . . P × P, by the same two continuations. But as the mates are entirely different in the two last-named variations, I think that they must count as separate duals.]

Solutions received from W. Nash, 4, 5, 6; Alpha, 4, 4, 4; W. Jay, 6, 5, 7; G. Woodcock, 4, 5, 5; G. W. Middleton, 4, 5, 4; W. de P. Crousaz, 4, 5, 5; "Tamen," 6, 5, 0; C. Johnston, 6, 5, 5; "Looker-on," 6, 5, 6; A. F. (Rugby), 4, 5, 4; J. W. Dawson, 4, 4 7; H. Boyes, 4, 3, 3; H. Myers, 4, 5, 7.

H. Boyes.—In your claims for duals in Nos. 8 and 9, you have in each case apparently overlooked that the Black KP can cover the final check. In reply to your question about No. 6, after 1. Kt × Kt, P to Kt4; 2. R × R, Black defends by 2. B × P.

G. W. Middleton.—Your claim for a dual after P × P by 2. Kt to B7ch is incorrect. After 2. . . . K to Q3 there is no mate.

G. Woodcock.—Please see above. As you give three continuations after 1. . . P × P and 1. . . B to Q6, I consider that you should score one point in each case for the correct dual, and lose one point for those that are incorrect. This cancels your score as far as those two variations are concerned. You score, of course, for the dual after P to Kt4.

B. G. Laws and Dr. Hunt.—Many thanks for your help in deciding the point referred to you.

H. D'O Bernard.—Much regret your retirement for this year.

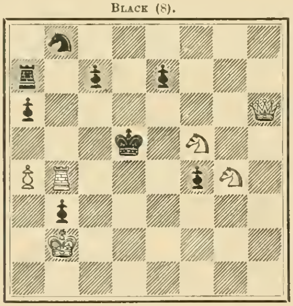
Composer of "Tubby."—I regret the slip in stating that Castling was the *key* of your problem. The move occurs as a continuation on White's second move, and, as such, is I think inadmissible in a tournament problem. It may be admissible for Black, the defender, but it is impossible to prove that White has not moved his Rook.

PROBLEMS.

No. 10.

"Possibilities."

Black (8).



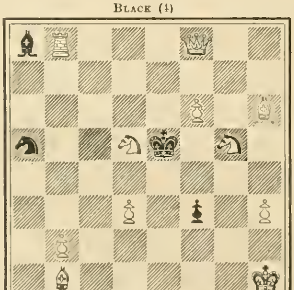
White (6).

White mates in three moves.

No. 11.

"With how much labour wast thou wrought."

Black (4)



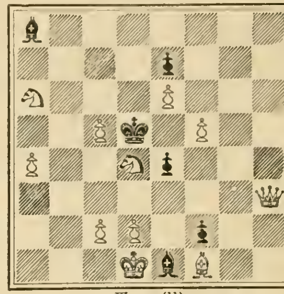
White (11)

White mates in three moves.

No. 12.

"Ariadne."

Black (6).



White (11).

White mates in three moves.

Note on Problem No. 6.—Mr. B. G. Laws, to whom we appealed on the question of dual short mates, gave as his opinion that they could not score. As Dr. Hunt, whom we asked for a final decision, was of the same opinion, which we have no doubt is correct, the point added temporarily to Mr. Johnston's score must be deducted. The following are therefore, at present, the seven leading scores:—

W. Jay	45
W. Nash	42
"Looker-on"	41
C. Johnston ...	40
J. W. Dawson	38
G. W. Middleton	37
G. Woodcock	37

CHESS INTELLIGENCE.

A return match by correspondence between the North and South of England will begin on October 1st, and conclude on June 1st. The teams on this occasion will be 100 aside, instead of 50, as in the last match. Players who wish to compete should write as soon as possible, if eligible for the North, to Mr I. M. Brown, 6 Wellington Place, Eccleshill, Bradford. If eligible for the South, to Dr. Hunt, 93, Richmond Road, Dalston, N.E. The qualifications are birth, or *bonâ fide* residence for the past twelve months. There will be a time limit of 48 hours, exclusive of Sundays and Bank Holidays.

The International Tourney at Hanover is beginning as we go to press. The competitors are limited to 18, and an unusually strong entry is probable, though Messrs. Lasker and Tarrasch will be absent. Herr Schlechter has recently defeated M. Janowski rather easily in a match at Carlsbad.

All manuscripts should be addressed to the Editors of Knowledge, 326, High Holborn, London; they should be easily legible or typewritten. All diagrams or drawings intended for reproduction, should be made in a good black medium on white card. While happy to consider unsolicited contributions, which should be accompanied by a stamped and addressed envelope, the Editors cannot be responsible for the loss of any MS. submitted, or for delay in its return, although every care will be taken of those sent.

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CONTENTS.

INSECT ODDITIES.—I.

By E. A. Butler, B.A., B.Sc.

While hardly any great division of the animal kingdom is devoid of species that exhibit fantastic and outlandish forms, the class Insecta is perhaps furnished with more than its fair share of these. We have already discussed in these papers some few of these extravagances of form, especially in the development of the limbs, and some good reason was generally found to be assignable for the quaintness of structure they exhibited. But even in the comparatively limited fauna of the British Islands, there are plenty of others which exhibit an equal, or even greater, bizarrerie, for which it is less easy to find an adequate reason. It may safely be affirmed that the order Rhynchota, or bugs and frog-hoppers, is more productive than any other group of the extraordinary forms to which we allude, and it may not be without interest to direct attention to a few of these oddities, which, although sometimes not of the commonest occurrence, will yet hardly fail to strike the observer when he does happen to meet with them.

The first that calls for notice is a little creature of such weird aspect that one can scarcely be surprised at its having been associated by country folk with the powers of darkness. Its scientific name is *Centrotus cornutus*, and amongst the peasantry of France, its dark colour combined with the sinister appearance of its fore-parts has gained for it the sobriquet "*Le Petit Diable*," while an English author speaks of it and its relatives as "Fiend-Flies," and an American entomologist describes them as "Brownie-bugs." *Centrotus* is not a very large insect, being only about ⅜ of an inch long, and, moreover, it belies its appearance by being perfectly harmless. When viewed in front (Fig. 1, A) it seems to show a brownish black

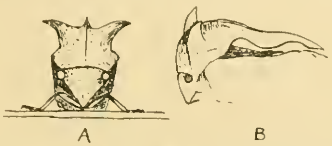


Fig. 1.—A, Front view of Face and Prothorax of *Centrotus cornutus*. B, Side view.

vertical face surmounted by a pair of curved horns, and this was quite enough in mediæval days to suggest a Satanic association. But it is not really the head to which this formidable appearance is due. The head in fact is neither very large nor conspicuous save for the rather large and wicked-looking eyes; but the prothorax has taken on the most grotesque form, rising perpendicularly above the head, surmounting it as with a head-dress. This head-dress runs out into the aforesaid horns at the side, while between them there is a little ridge which, if we follow it backward, we see gradually extending and enlarging till it forms a long sword-like appendage (Fig. 1, B) reaching nearly to the end of the body, and looking like a sort of stiff puggaree to the aforesaid head-gear.

There is nothing remarkable about the rest of the insect, It has four ordinary membranous glassy-looking wings with distinct nervures, the upper pair being stouter than the lower, and its legs and body are quite normal in shape. It is simply this extraordinary development of the thorax that makes it such a wild and odd-looking being. It is impossible to say whether this quaintness of form has any bearing upon the insect's present mode of life, or is in any way in correspondence with its usual environment. It is an inhabitant of woods, living amongst the herbage, chiefly in our southern counties, but too little is known of its habits for it to be possible to give any adequate explanation of its form. It belongs to one of those orders of insects which do not undergo any very great change of form during the course of their life, and which never pass into the quiescent stage of neither taking food nor moving about—in other words, its metamorphosis is of the kind known as "incomplete." The young insect is shaped something like the adult, but of course has no wings, and the thoracic horns and tail do not attain their characteristic form till the last moult. It is a vegetarian in diet, sucking the juices of plants through a short beak, and is therefore probably mild and inoffensive in its ways, so that the only use one can suggest for its curious armature is that it should act as a terror-producing signal upon any would-be assailant.

In other parts of the world, other species are found, more or less closely allied to this, in which the thorax presents far more grotesque developments than in the present case. They constitute the family *Membracidæ*, of the sub-order Homoptera, and it would be difficult to find any other family of insects in any order which can show an equal range of fantastic development of the thorax, or, for the matter of that, of any other part of the body. Horns, spines, hooks, knobs, forks, blades—every conceivable monstrosity may be found in the exotic members of this family, and one would think that Nature must have been in a sportive mood when she made them. Speaking of some American species, a well-known authority says: "If the young naturalist wants to laugh, let him look at the faces of these brownie-bugs through a lens. Their eyes have a keen droll look, and the line that separates the head from the prothorax gives them the appearance of wearing glasses. In some cases the prothorax is elevated above the head, so that it looks like a peaked nightcap; in others it is shaped like a Tam o' Shanter, while others have prominent horns."

In our next example it is the head instead of the thorax that has developed grotesquely. The insect is called *Eupelix cuspidata* (Fig. 2), and it belongs to the same order Homoptera as our first example, though to a different family. It is a very different insect from the preceding, being smaller and narrower, and of a pale yellowish brown colour. There is nothing at all remarkable about it except the head, which is certainly a most extraordinary structure. It is shaped very much like a miner's shovel, running far forward as a thin and flattened triangular plate, scooped out in the middle of its disc, slightly rounded at the edges, and turned up at the tip. This leaf-like appendage is slightly transparent, and is often prettily marked with a series of blackish mottlings which give it somewhat the appearance of black lace. The wings when closed are placed along the sides of the body in a nearly vertical position, and their surface is in some instances more or less plentifully sprinkled with minute blackish dots, as though it were slightly dusty. The large compound eyes are situated in the hinder part of the head, and the curious shovel-like plate passes right in front of them, and in fact bisects their surface, leaving part of each eye above and part below its level. One would think that this arrangement must interfere with vision, at least in the forward direction, though no doubt the insect has an unimpeded range of view on each side. The exact shape and size of the shovel part of the head varies a good deal, so much so indeed that different names have been assigned to the different forms under the belief that they were distinct species. However, as it is possible to find large and small heads, as well as intermediate ones, in the same batch at the same spot, it seems more probable that all the differences of form are mere variations within the limits of a single species.

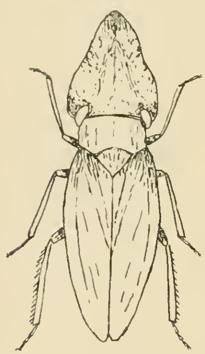


Fig. 2. *Eupelix cuspidata.*

It is impossible to say what is the reason for this curious conformation of the head. Practically nothing is known of the habits of the insect, save that it lives amongst low plants, grasses and the like, especially in dry sandy places. In all likelihood there is little else to be known; they probably live very uneventful lives, and in spite of their peculiar shape, they can hardly be very important factors in the general scheme of things, or have any very great influence in nature. Their numbers are not large, and the amount of sap they consume in the course of their lifetime is no doubt infinitesimal, so that there is perhaps some justification for the contempt expressed for them by a countryman to whom I once showed some specimens when he came upon me in the act of collecting them. His fancy was greatly tickled at the thought that an otherwise apparently sane individual should so far forget his dignity as to go down on his hands and knees in the open country and grovel amongst the roots of mere weeds for what the interlocutor was pleased to call "barley-corns," and he was fain to call the attention of another rustic to the strange phenomenon, so that they might enjoy a laugh together at the expense of the mad naturalist.

Within this same order Homoptera there is still plenty of scope for finding other oddities, and the next we shall select is called *Ledra aurita*. This is almost the largest species of Homoptera we possess in the British Islands; there is in fact only one that is larger. It is at least ⅝ inch long, and is found, though not very frequently, in oak-woods. It has a thin, flat head, somewhat after the fashion of *Eupelix*, though not nearly so large as in that insect; but the greatest peculiarity, and that which gives it its name *aurita*, "eared," is a couple of large flaps which rise from the back of the prothorax, one on each side, like ears. The aspect of the insect changes very much according to the position in which it is viewed, and it is not easy to say which is the best to show off its characteristic peculiarities. Perhaps a view taken from the front, and a little to one side, will reveal most effectively the relative position and odd forms of the most strangely shaped parts, and such a view is given in the figure (Fig. 3).

This insect is the solitary representative of its family, and as such, therefore, can hardly be mistaken. It is of a brownish colour tinged with green, but the green tint soon goes off when the insect is dead, and it then appears entirely of a dirty brown, lighter or darker as the case may be. Its hind legs are peculiar, being very much broadened, and ornamented on the outer edge with a dense fringe of fine hairs, as if it had been intended to be a swimming insect. Its larva is, if possible, a stranger looking creature than itself, and were it not for its large and broad hind legs, proportionately broader even than in the adult, it might almost pass muster as a woodlouse. The old naturalist Geoffroy, who describes our first insect as "*Le Petit Diable*," calls the present one "*Le Grand Diable*."

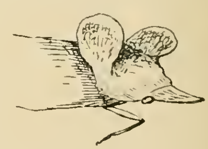


Fig. 3.—Side view of fore-parts of *Ledra aurita.*

Still keeping to the order Homoptera, we may next select the insect called *Asiraca clavicornis* (Fig. 4). This, again, is not often met with, though when seen it cannot be mistaken. It is found amongst low herbage in dry places, and is most readily obtained by sweeping such herbage with a strong net. But even when a specimen is in the net, it is by no means a foregone conclusion that the collector may call it his own, for the little creature is an excellent jumper, and darts nimbly about in the most instantaneous manner in totally unexpected directions, and hence its final capture is not always the easy process that might be imagined. For the quaintness of this insect's appearance, it is especially the first two pairs of legs and the antennæ that are responsible. The fore-wings are glassy and transparent, with their nervures marked with dark dots, from each of which springs a stout hair, and in these features *Asiraca* is only a somewhat exaggerated repetition of its relatives. But though the wings are of almost normal type, the antennæ have run into an extravagance of form, projecting from the sides of the head like a couple of drumsticks. Their basal joint is a long, flattened, angular piece of apparatus, which is succeeded by a sort of knob, and this again is crowned with a long and tapering black bristle. The fore-limbs, however, are the strangest part of the whole anatomy; their thighs and shanks, which are in the main dark-coloured, are enormously broadened and at the same time flattened; the shanks taper away almost to a point, irresistibly reminding one of the peg-top trousers of forty years ago, and their extreme tip is almost white. This little white patch is followed by the minute and dark-coloured foot, and thus by its being sandwiched in between two dark patches, a striking and artistic contrast is displayed. The second pair of legs are very similar, but not quite so broad. It has been suggested that these curious legs may be of use to the insect in making its way about in the narrow spaces near the roots of the rough herbage it frequents, but apparently this is no more than speculation.

Fig. 4.—*Asiraca clavicornis.*

Our next example shall be from the allied sub-order Heteroptera, which goes with the Homoptera to make up the order Rhynchota. It is called *Verlusia rhombea* (Fig. 5), the specific name *rhombea* referring to the curious angular shape of the abdomen, which is just that of the geometric figure known as a rhombus. It is a yellowish-brown insect, with its upper wings partly stiff and horny, and partly thin and membranous, and its lower pair wholly membranous. When the wings are opened the body is seen to be of a deep yellow colour, with a black velvety patch at the base. The body is very thin and flat, but the expanded angular margins bend slightly upwards, so that even when the wings are closed and fitting tightly over the body, these margins still form the highest points, and the rest of the body lies down as it were in a hollow. A rather important result follows from this peculiar configuration. If an insect in the course of its daily occupations should happen to fall on its back, it often finds some little difficulty in righting itself. If the back is convex and the legs are fairly long, a few wild struggles, by pushing with the legs on one side and using those of the other as a prop, will generally manage to tilt the creature up, till at last it topples over and rejoices to find itself right side uppermost. But if the back be flat, or worse still, concave, and the legs short, the task is far more difficult, and its accomplishment often depends upon some special mechanical contrivance, more or less ingenious. *Verlusia* is an example in point. From the thinness and concavity of the body, together with the elevation of its margins, it follows that if this insect has the misfortune to be capsized, its chances of righting itself in the ordinary way would be rather remote, and but for some other arrangement, it might have to remain indefinitely sprawling on its back, kicking its legs in the air. But it is then that we see one of the uses of the extremely thick and clumsy looking antennæ, which are a good deal stouter and stronger than the legs themselves. By pressing the tips of these on the ground, the bug manages to hoist itself up till it is supported on a tripod consisting of these two tips and the end of the body. Then, by suitable shiftings of one or other of the antennal props, aided by struggles with the legs, it at last overbalances, and so returns to the normal position. Apparently, therefore, in this case there is a co-ordination between the shape of the body and the structure of the antennæ which cannot be accidental, though one would not hesitate to admit that there may be other reasons also for the flatness of the one and the stoutness of the other.

Fig. 5.—*Verlusia rhombea.*

Our next oddity is a lovely little being belonging to the same sub-order, and representing a family of which we have in this country about twenty species, some of them very abundant, others equally rare. They form the group of small insects generally known as Lace-Bugs, from the peculiar formation of their wing-covers. Of this group, our selected representative, *Derephysia foliacea*, is certainly the most remarkable in shape and appearance. As all its beauties and peculiarities are crowded into a length of not more than $\frac{1}{8}$ of an inch, a hand lens, or even a low power of the compound microscope, is needed to give a true idea of its form. Applying such aids to vision, we see that its little head is overarched by a sort of helmet or cowl, composed of transparent membrane, which is divided up into a few distinct areas by strong brownish nervures. This hood is really a part of the prothorax, and from it there run three upright keels of the same material down across the little black thorax. From the sides of the thorax rise, like an Elizabethan ruff, two similar stiff, broad membranes, each rendered net-like in appearance by the nervures which divide it up into cell-like areas. The upper pair of wings, again, is made of the same sort of lace-like membrane; their central area is raised, as are also the outer margins, which stretch considerably beyond the body and seem to continue the line of the thoracic frill. Thus the whole insect seems to be not only covered with lace, but also surrounded by a deep frill of the same material, and the glassy membrane which fills the meshes of the lace glitters as the insect moves and the light falls on it in different directions. No drawing is here given of this little bug, as none can do justice to it, or show its real form, which must be seen under the compound microscope to be fully appreciated.

These delicate little beings are fairly common, and may be found by anyone who will take the trouble to look for them. They are retiring in habits, and do not court notice. But those who are willing to spend a few hours searching in likely spots, to turn over dead leaves or other rubbish in woods or by roadsides and under hedges, or to beat ivy, holly and other dry bushy vegetation over a net, will be sure to be rewarded for their trouble by finding specimens, whose movements can then be watched at leisure. Those who do not care to undertake such a search, but would still like to see creatures similar to this in a state of nature, may easily do so by searching the flower heads of that common weed, the Scotch thistle. There is one particular lace-bug, called *Monanthia cardui*, which lives on these thistle-heads, lying among the scales on the rounded part outside, and it is sure to be found wherever the thistle occurs. Though it is a very pretty insect, and will give a good idea of what a lace-bug is like generally, it is neither so elegant nor so quaint in form as the little *Derephysia* described above.

For our last oddity in the present paper, we must go to a weedy pond, and search for the little water-bug called *Plea minutissima* (Fig. 6). We pull out a mass of the water weeds, and spread them out on a piece of macintosh. We soon notice some little fat whitish bodies moving slowly about amongst the weeds; these are the objects of which we are in search, though they do not at first sight seem to be insects at all. If we separate one of them from the wet mass, let it dry itself, and bring a hand lens to bear upon it, we find it is really a six-legged being, and therefore an insect, though its legs are not very noticeable, as they are kept near the body and are of the same pale colour. It has a head as bread as the body, with two large masses of eyes at the sides, and a very humped back, which descends almost perpendicularly behind, making the little being look like a very short and tubby inverted boat. Very close scrutiny will reveal a sloping line on the visible wings, dividing their area into two parts, the clavus and corium of the ordinary bug type. Turning it over on its back, we note the little beak, which confirms the indications of the wings, that it is a Hemipteron. The whole surface is indented with little pits, as though it were grievously pock-marked. This odd little being is a near relative of the water boatman, and often occurs by hundreds in our ponds, where it lives an uneventful life amongst the weeds.

FIG. 6.—*Plea minutissima.* Side view.

Thus all the oddities we have considered in this paper belong to the one order Rhynchota, or Hemiptera, in either one or other of its sections, the Heteroptera, or bugs proper, and the Homoptera, or frog-hoppers. In our next paper we shall consider some oddities belonging to other orders.

THE AIR OVER LONDON.

By the Rev. JOHN M. BACON.

As long ago as 1842, John Wise, of America, made an important statement respecting general upper currents which I believe will be fairly universally accepted at the present day. Wise adopted the career of a professional aeronaut, starting with no previous training, and there being no experts at that time in his own country his investigations and deductions were from the beginning wholly independent. He built his experimental balloon of mere longcloth, invented his own varnish, and, step by step, collected his facts with intelligent diligence not to be surpassed. At the end of a career of many years he convinced himself of the possibility of crossing the Atlantic in a balloon of adequate size, and applied to Congress for funds to make the attempt, stating in his own words:—"It is now beyond a doubt in my mind established that a current from west to east in the atmosphere is constantly in motion within the height of 12,000 ft. above the ocean."

I have always looked upon this as a very valuable, practical and independent confirmation of the theory with which we are now familiar, namely, that somewhere, and as it would seem at an accessible height, there is a general air stream in our latitudes following the direction of the earth's rotation. It is to this general and moderately lofty upper west wind that, in my opinion, we must refer certain important conditions which can be readily noted by the man in the street with regard to the air above London.

It would seem a common rule that when contrary lower winds meet and mingle with this upper current the air aloft grows hazy, robbing direct sunlight of much of its intensity; while, on the other hand, with lower westerly winds Londoners may look for their clearest air, and this not only for the above reason but also because of the blowing away from London proper of the smoke of the city. As to the dissipation of smoke I shall have a word to add presently. However, with regard to a certain condition of exceptional clearness over the east side of London, it has been stated as the result of long-continued observation at Greenwich, that whereas over and beyond the river to the N. and N.N.E. there is usually hazy distance, this haze is occasionally replaced by remarkable clearness, at which times rain is the invariable consequence before the next morning. Under such circumstances we cannot suppose the clearness to be attributable to west winds, which, as some meteorologists maintain, by their moisture cause absorbent dust particles to become too heavy to remain in suspension; for west currents in the present case would assuredly bring with them smoke clouds gathered from all London.

It would be interesting to investigate what would be the nature of the air if analysed at a time when great visibility is manifest, at the average height at which haze is usually detected; and here I am able to give a few results gathered when chances have afforded me the opportunity. Such chances are of course rare, for, in the first place, the occasions when a balloon voyage can be made fairly over London are infrequent, and the whole period of a flight overhead being limited it may well happen that the short time at disposal may have to be devoted largely to other matters.

Three times, however, during last summer I sailed directly and leisurely over London, at moderate but varying heights, when I was able to make observations both as to haze and also as to palpable dust in suspension; while I have made many similar observations from some of the highest accessible buildings. I would first call attention to the fact that a series of photographs makes evident—what indeed was patent to the eye—that haze, as viewed from aloft, hung persistently over certain quarters, such haze having no reference to the angle of illumination. For example, in an aerial travel at about four thousand feet altitude over the heart of London from the south-west to the north-east, keeping the eye always S. and S.E., at the start the river at Chelsea and the Surrey shore were perfectly clear, as in due course were also Trafalgar Square and Westminster, and again later, remarkably so, the region east of London Bridge. But over St. Paul's, Blackfriars, and as far as Southwark Bridge, a thick haze prevailed. In the next place, photographs from lofty buildings show how on many occasions a haze which blotted out the town late in the evening, and again early the following morning, was strikingly absent through night hours. The illustration given affords an example of this. It was taken during a January night, and shows great clearness of atmosphere, whereas from similar, as also from lesser heights, photographs taken the afternoon before and the forenoon following showed no definition whatever.

With regard to dust in suspension over the town, my observations go to show that in calm weather this will hang at certain levels in strata, or, as I am led to believe, not infrequently in definite clouds which yield to influence of breeze, which are higher in dry and lower in moist weather, and which are largely washed out of the air by summer showers. I have often found that at some height,

Photograph of New Oxford Street, London, showing St. Giles' Church. Trails of light from passing vehicles alone visible. Six hours' exposure.

generally about 6000 feet, it is possible to surmount the haze and look down upon its surface as though the grosser matter in suspension had a definite upper limit. Above this limit the day sky wears a darker blue and at night the stars redouble their splendour.

As to the actual nature of the dust collected and examined I have certain information to give. Dr. Angus Smith, who used methods very similar to my own, discovered besides formless matter actual crystals in the air under certain circumstances, metallic matter in the form of dust resembling rolled or torn plates of iron in railway carriages, and so on. High over London I have found nothing of this nature, but I have met with a great quantity of such dust as will settle by night on the furniture of a room together with much of altogether larger dimensions resembling chaff, filaments, and woollen fibre; such dust, in fact, as would arise off the thoroughfares in dry weather, or from the sweeping out of houses. But such dust was more in evidence at from 3000 to 5000 feet above the house-tops than nearer the ground. It would seem to accumulate at the higher levels, and then in anti-cyclonic conditions when mixed with smoke and under circumstances favouring fog one would like to know exactly what part this dust-laden canopy plays.

When the fog comes down it often begins with the downrush of a dense mass which when viewed from a lofty building seems to swamp the lower roofs as with a murky wave. This presently lifts again into space, but only to return again and again till it finally settles down and the fog becomes uniformly dense and general. These conditions I have photographed from various heights up to that of the golden gallery of St. Paul's, but the results, though highly instructive, do not lend themselves to reproduction.

As to the far travel of London smoke when it is not detained in fogs over the city, there is plenty of evidence forthcoming. In days of bright sunshine in the open country the fairest and most-favoured suburbs of the West End may be partially over-clouded if an east wind causes London smoke to set in that direction. This same smoke may be actually seen at thirty miles to leeward, and when it drifts away as London fog it may be smelt for twice that distance. The smoke from the Black Country has been stated to be carried down the wind over vast areas, a fact which must of course be open more or less to conjecture, but I can speak from ocular evidence of the extraordinary passage of smoke travelling far and wide, but not ascending more than a very moderate height into the sky. It was on a calm clear night last summer that I made a night voyage over London, starting at 3 a.m. With gradually increasing altitude, Fulham was crossed, then the suspension bridge at Battersea, next Lambeth and Peckham, and so out over Kent. As far as could be discerned, London proper at all heights was as free from smoke as can be conceived, but when the town was left far in our wake our course took us over some cement works, whose chimneys were pouring volumes of smoke into the sky. This smoke, however, as viewed from our level of 4500 feet, seemed to rise no considerable height anywhere into the atmosphere; on the contrary, it rapidly spread into a low-lying layer, and then travelled outwards without sensible thinning away as far as the eye could reach. At twenty miles distant it was on the earth, still making itself unpleasantly manifest.

In the above case, of course, the smoke was drifting away as fast as formed, and no dense accumulation over the land was possible. Had the air been quiescent the case would have been very different, and it may not be difficult to form a reasonable conception of what the air over London might be found to be if explored by balloon at a time of visitation of fog. As to what may be observed from the highest accessible point of St. Paul's I can record some experiences. On many days of moderate fog you may be able to climb above the actual fog limits, but in the exceptional fogs preceding last Christmas this was not so. Under these circumstances what are the actual dimensions and conditions of the fog? In one of the early numbers of Knowledge, R. A. Proctor points out by mathematical reasoning, depending on the amount of light that even in densest fogs actually does struggle through from the clear sky above, that the depth of the fog layer cannot be very great. And this seems probable on every account. Particles of carbon, being good radiators, must readily reach the dew point, and becoming heavy with deposition of moisture, must in circumstances of fog be incapable of rising high into the atmosphere.

But if the fog be shallow, it is moreover presumably in a condition of instability. The fog itself checking radiation, there must be considerable difference of temperature between its lower and upper limits. Nor is this all; the alternations of warm and cold air streams so often recorded in balloon ascents, and also deduced from kite experiments, are in my experiences, which are now not few, very frequently met with above a cloud layer. Such alternations seeming indeed to be often independent of visible cloud, and in ascents over London they are possibly more noticeable than over the open country. (This might indeed be inferred as probable when the variations of radiation from a town like London are considered.) Under these circumstances we may suppose that some small source of disturbance might be sufficient to cause the densest fog to break away upwards, or, in the common phrase, to "lift" in that magical manner so often observed.

One other factor operative in the dispersal of fogs should not be left out of account, namely, the diverse upper currents so often encountered over London. Charles Green called attention to these as far back as 1838, when at less than half a mile above the earth his course changed through N.W., N., and N.E. within the limits of the metropolis. I would submit that these varying currents are the rule over London.

THE NUMBER OF MOULTS UNDERGONE BY DRAGON-FLY NYMPHS.

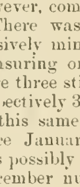
By the Rev. ARTHUR EAST.

THERE appear to be so few observations of the number of times that the nymphs of dragon-flies change their skins —indeed, so far as the writer is aware, the exact number is unknown—that possibly a few notes on the ecdysis of *Æschna cyanea* may be acceptable to that small, but increasing number of students who devote some attention to that interesting group of insects known as the Odonata.

The moults in the later stages of the nymph's growth are very easily observed and counted, but it is the earlier ones, and especially the earliest of all, where the difficulty comes in. This, of course, is owing mainly to the insects being aquatic in the nymphal stage, and also to the minuteness of the eggs of even the largest dragon-flies; added to this there is the difficulty of keeping the imagines in captivity so as to make the females deposit their eggs where they can be kept under observation, and the additional fact that when the minute eggs are laid, they are either secreted beneath the cuticle of aquatic plants or else dropped at random into the water. Accident, however, comes sometimes to the rescue.

There was found in an aquarium in July an excessively minute and solitary nymph of *Æschna cyanea*, measuring only 6½ mm. in length, and in addition there were three still more minute cast nymph skins, measuring respectively 3½ mm., 5 mm., and 6½ mm., evidently belonging to this same nymph, as the water had been unchanged since January. The smallest skin, measuring 3½ mm., was possibly the first or second skin cast. A writer in the December number of the *Entomologist*, referring to this particular instance, says "A very few minutes after leaving the egg, some young nymphs moult. This I have observed in *Libellula quadrimaculata* (at Jena, Germany, in June, 1896) and in our American *L. pulchella* and *Sympetrum vicinum*. It is also mentioned for *Epitheca bimaculata* by Heymons (1896). It is likely that such a moult will be found to occur in *Æschna*. Previous to this first moult, the legs of the young nymph are adherent to each other and are not movable, so that Heymons says that we cannot yet speak of a larva, but of a hatched embryo. The first moult frees the legs, which are at once put into use by their possessor.

The day following that on which the nymph was first discovered it changed again, and became 10 mm. in length; on Augsut 3rd, it became 13 mm.; on August 15th, it became 18 mm.; and at this, its sixth moult, the four rudimentary wing-cases first appeared.



Nymph of *Æschna cyanea* after the 6th moult, showing first appearance of wing-cases.

The seventh moult was on August 25, when the nymph measured 20 mm, the rudimentary wings were further developed, and, strangely, there could be seen through the transparent skin the wing-cases of the next moult, now for the first time advanced from the sides and lying touching one another on the median line of the back.

Then followed a change on September 22, when the nymph measured 25½ mm., and after this a long rest of four months to January 24, when the measure became 29 mm. Unfortunately during the winter this nymph died, and there had to be substituted *Æ. cyanea II.*, measuring, however, exactly 29 mm., three others of the same measure being kept in reserve in case of disaster. No disaster occurred, happily, and *Æ. cyanea II.* completed her course (for the nymph was a female) without accident. The subsequent changes and measurements were as follow:—10th moult, May 5th, 32 mm.; 11th moult, June 6th, 38 mm.; 12th, final emergence of the imago, July 14th, the nymph having reached 43 mm.

The number of moults undergone will therefore be twelve, supposing that the smallest skin found was that of the first moult, if of the second moult then the total number must be advanced one, making thirteen as the number.

For convenience of reference the whole observation may be given in tabular form—

? 1st moult, date unknown,	measure 3½ mm.
2nd moult, date unknown,	measure 5 mm.
3rd moult, date unknown,	measure 6½ mm.
4th moult, July 31st,	measure 10 mm.
5th moult, August 3rd,	measure 13 mm.
6th moult, August 15th	measure 18 mm.
7th moult, August 25th,	measure 20 mm.
8th moult, September 22nd,	measure 25½ mm.
9th moult, January 24th,	measure 29 mm.

On April 30th, substituted another nymph in place of original one, which died.

10th moult, May 5th, measure 32 mm.
11th moult, June 6th, measure 38 mm.
12th and final, July 14th, nymph measured 43 mm.

From this it will be seen that there is a fairly even growth, on an average, of 4 mm. for each ecdysis, but that for nearly eight months, viz., from September 22nd to May 5th, there was only one moult. This was not owing to lack of food, as worms were frequently offered, nor was the nymph at all torpid; one can only suppose that it is a necessary arrangement, as food must ordinarily be extremely difficult to obtain during the winter months.

That the nymph should die during the observation was unfortunate for both observed and observer, but the cause showed very clearly the extreme value of that wonderful endowment possessed by these creatures of being able to breathe at will either the air dissolved in the water, or common air at the surface, as referred to in a previous article on this subject.* The small aquarium in which the nymph was kept had been cleaned, and the sides were no longer rough with green algæ as before. As the water got stale the nymph would ordinarily have climbed the side, and, protruding the rectum, have breathed the outer air. The slippery sides, however, forbade this, and the nymph died of asphyxia—breathing, I fear, maledictions on the stupidity of its captor.

The further point remains—which some reader can, perhaps, clear up—as to when the eggs of *Æ. cyanea* are hatched. The imagines appear late in June and during July, but ovipositing does not seem to begin until much later in the year, the end of August or beginning of September; yet, even so, as late as July 30, a nymph only measures 6½ mm., leading one to suppose at first sight that the eggs lie dormant during the winter and are hatched when the warm weather begins; but looking to the fact mentioned above that during the second winter the nymph scarcely grows at all, as evidenced by there being one moult only between the end of September and the beginning of May, we may perhaps suppose that the young nymphs are hatched in autumn, but that they grow but very little during the first winter.

But whether the young nymphs are hatched in the autumn or spring, it is clear that nearly two years are required to perfect the imago, viz., from the autumn of one

* KNOWLEDGE, October, 1900.

year when the eggs are laid to the next June or July *year*, when the perfect insect emerges, a period, say, of twenty-two months. The earliest appearance of *Æ. cyanea* known to the writer is June 25, and the latest date on which this variety has been seen flying about is November 2nd.

EUPHRATEAN DIVISIONS OF THE CIRCLE.

By ROBERT BROWN, JUNR., F.S.A.

THERE are in the British Museum three cuneiform Fragments, numbered respectively *Sm.* 162; 83-1-18, 608 and 81-7-27, 94, the two latter of which have not hitherto received the attention they well deserve. For brevity I will refer to these Fragments as *A*, *B* and *C*. Frag. *A* was discovered by George Smith 'in the palace of Sennacherib,' and was subsequently discussed with much ability by Messrs. Bosanquet and Sayce,(1) but not in connection with the general question of the reconstruction of the Euphratean Planisphere. So far as I am aware, Frags. *B* and *C* have not been studied except by myself. Frag. *A* is a portion of a sphere consisting of an outer and an inner circle, each divided into two parts. In the outer circle to the left is written the name of the 8th month of the year, and below it 'the Constellation Beast-of-death' (= *Lupus*). Below this is the number '140.' Below this, in the inner circle, is written 'the Constellation the Scorpion' (= *Scorpio*); and below this name is written the number '70.' In the outer circle to the right is written the name of the 9th month of the year, and below it 'the Constellation the Ancient Altar' (= *Ara*).(2) Below this is the number '120.' Below this, in the inner circle, is written 'the Constellation the Archer' (= *Sagittarius*); and below this is written the number '60.'

Frag. *B* is a portion of a sphere consisting of an outer and an inner circle. In the outer circle is written 'the Constellation the Scorpion,' and below this name is the number '70.' Below this, in the inner circle, is written 'the Constellation the King,' and below this name is written the number '35.' It will therefore be observed that the original Planisphere consisted of 3 circles, and that fortunately one segment of it has been preserved, viz.:—

Outer circle—Constellation	*Lupus.*	No. of degrees,	140.
Central " "	*Scorpio.*	"	70.
Inner " "	*Hercules.*(3)	"	35.

Of course the reader will notice the highly interesting fact that these constellations, alike in name and in position, are those of our own modern sphere; but, as I am now only speaking of divisions of the circle, I merely mention this in passing.

Frag. *C* is a portion of a sphere consisting of an outer circle divided into two parts. In the part to the left is written the name of the 11th month, and, below it, 'the Constellation Fish-of-the-Canal' (= *Piscis Australis*). Below this is the number '80.' In the part to the right is written part of the name of the 12th month. Thus in these Fragments we have the 8th month connected with 140°, the 9th with 120°, and the 11th with 80°. Hence, it is obvious that this outer circle was divided into 12 parts, one for each month; and, further, that each of the 12 parts was divided into 20°, whence the whole circle consisted of $12 \times 20 = 240°$. Lastly, as the 11th month was connected with 80°, a lower number than that connected with the 9th month, the 12th month must have been connected with 60°, the 1st with 40°, and the 2nd with 20°. Hence, at the time of the formation of this circle the Bull, the constellation of the 2nd month, led the year; and thus the arrangement of the circle was prior to B.C. 2540.

It is equally obvious that the central or zodiacal circle consisted of 12 divisions of 10° each, = 120°; and that the inner circle consisted of 12 divisions of 5° each, = 60° All this can be seen at a glance on reference to Fig. 1, and

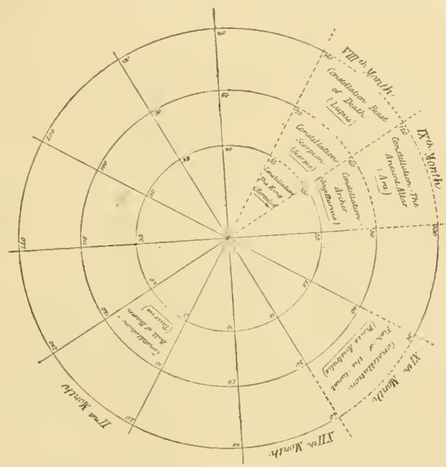


FIG. 1.—Euphratean Planisphere. Reconstructed in accordance with the Monuments. (The dotted lines show the extent of the existing Fragments.)

when the principle contained in the 3 Fragments was once grasped, the restoration of the Planisphere followed as of course, and is a matter of mathematical certainty. The entire Planisphere was intended to embody a formal scheme of 36 constellations, 12 northern, 12 central or zodiacal, and 12 southern; but, as I am not speaking of stars and their groups, I shall not again refer to this fact. We thus obtain three further divisions of the circle, into 60°, 120°, and 240°; and what at once strikes us about these divisions is the prominence they give to the numbers 6 and 10, and to 60, the result of their multiplication. The number of degrees in the inner and outer circles depends upon the number of degrees in the central circle, and is obtained by halving and doubling respectively. But how was the number 120 obtained for the central circle? I wish to deal as much as possible with fact only, and not with theory, still less with mere possibility; and therefore will merely remark that, as noticed, the number Ten was regarded as 'many,' and that the process of multiplication by 10 appears to have been originally considered as a mode of expressing 'a great number,' in fact as an intensification. Moreover, we shall see from other figures and totals that, as numerical computation advanced, this method of expressing a great, vast, or enormous number was frequently employed. A number

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[1] *Monthly Notices* of the Royal Astron. Soc. Vol. XL. No. 3, Jan. 1880.

[2] Vide R. B. Jr., *Primitive Constellations*, ii. 6-9.

[3] Amongst the later names of this constellation are *Malica* (= Phœnician *Melekh*, 'the King,' = Babylonian *Šarru*, = Sumero-Akkadian *Lugal*, the name on the Fragment), *Melicartus* (= Gk. *Melikertês*, = Phœnician *Melqârth*, 'King-of-the-City,' the Tyrian Hêraklês). and *Maceris* (= Gk. *Makar*, = Phœnician *Melqârth*). The Gk. name *Hêraklês*, for which there is no Aryan derivation, is a rendering of the Phœnician *Harekhal* ('the Traveller'), the wandering sun-god, patron of colonies like Apollôn. *Hêraklês* = Latin *Hercules*.

was multiplied by 10, then the product was multiplied by 10, and then the result was multiplied by 10. The original number was thus triply intensified, and by this means totals were attained, not literally true, but merely expressions of vastness in the number of things or of years. It is necessary to say this much in illustration of the facts of the case. The central (zodiacal) circle was already, in the nature of things, connected with the number 12; and this mode of intensive expansion raised it to 120 divisions or degrees. I do not, however, assert that this principle is the only link between 10 and 12 in the matter. These circles thus showing a sexagesimal method, we find, as might be expected, the same principle confirmed by the cuneiform writing. The single wedge which represents '1' also stands for '60.' In Euphratean computation 60 is also the unexpressed denominator of a fraction; and we possess a tablet which 'gives a table of squares and cubes correctly calculated from 1 to 60.' The inhabitants of the Euphrates Valley further 'sub-divided the unit into 60 equal parts, and each of these parts into 60 further equal sub-divisions.'[4] And now, turning to a modern dictionary, we read:—

'*Sexagesimal arithmetic*, a method of computation by sixties, as that which is used in dividing minutes into seconds.—*Sexagesimal fractions*, fractions whose denominators proceed in the ratio of 60; the denominator is 60 or its multiple. These fractions are called also astronomical fractions, because formerly there were no others used in astronomical calculations. They are still retained in the divisions of the circle, and of time, where the degree or hour is divided into 60 minutes, the minutes into 60 seconds, and so on.'[5]

Thus do the thought and practice of early man in the Euphrates Valley still dominate the modern world. So small is the sphere of invention and of original mental effort; so much easier is it to beg, borrow or steal.

I pass on to notice two other Tablets, the first, *K*. 90, details the monthly progress of the moon through a circle of 480°; the second, Tab. 84-7-19, 273, details the same progress through a circle of 360°. *K*. 90 has been more or less treated of by Lenormant and by Messrs. Bosanquet and Sayce[6]; and the second Tab. by me in the *Proceedings* Soc. Bib. Archæol., Feb. 1900, where I give a copy of the remaining part of it. The calculations of the moon's progress in these two circles, although in some details at present unintelligible to me, are in perfect harmony. In the circle of 360° the figures are, as they should be in order to correspond, ¼th lower.

The two Tablets compare together thus:—

	Tablet *K* 90. (Circle 480°)	Tablet 84-7-19, 273. (Circle 360°)	
	°	° ′	
Lunar advance 1st day	5	3 45	
,, ,, 2nd ,,	5	3 45	
,, ,, 3rd ,,	10	7 30	
,, ,, 4th ,,	20	15	
,, ,, 5th ,,	40	30	
	80	60	= ⅙th of the month and circle.

Why the moon's apparent pace is thus varied is a question to which I invite the attention of astronomers. It does not concern the divisions of the circle. The first Tablet, written in Sumero-Akkadian, is of very high antiquity; the second formed part of the great astronomico-astrological work *The Illumination of Bêl*,[7] and therefore belongs to the third millenium B.C. A circle of 360° must also be connected with a year of 360 days, and in another Tablet[8] the year is stated to be composed of 12 months and 360 days. In these circles of 360° and 480° the numbers 6 and 60 are equally prominent as in the smaller circles.

I will next notice how the circle-numbers become cycle-numbers by the process of intensification already referred to. My late friend Geo. Bertin, in one of his lectures on Babylonian astronomy, stated that the Babylonians 'admitted the existence of a cosmical year. . . . This period was one of 360,000.' I have no original reference before me, but the statements of the Greek writers are in themselves sufficient to show that Bertin was right. The 360° of the circle multiplied by $10 = 3600$, which $\times 10 = 36{,}000$, which $\times 10 = 360{,}000$, a total the result of the principle of triple intensification. The cosmical or divine year is thus vastly greater than the human year. According to this computation a divine day would = 1000 years; and this reminds us of the familiar statement in our own Sacred Books that, from the Divine standpoint, 'one day is as a thousand years.' When, therefore, Epigenês of Byzantion (tem. Augustus), who is stated to have studied in Babylônia, declared[9] that the Chaldæans had brick records of astronomical observations extending over a period of 720,000 years, these figures actually represent 2 cosmical years. The double of this, 1,440,000 or 4 cosmical years, is given by Simplikios[10] as the period of these observations. Bêrôsos and Kritodêmos of Kôs are said[11] to have put this term at 480,000 years, a number arrived at by treating the circle of 480° in a similar manner. Thus $480 \times 10 \times 10 \times 10 = 480{,}000$.

It is to be further noticed that the Euphratean ideas connected with cosmic periods appear to have influenced other Asiatic nations. Thus, the zodiacal circle of $120° \times 10 \times 10 = 12{,}000$, reappears in the Iranian divine year of 12,000 ordinary years, and which gives 1000 years for each month and for each sign of the zodiac.[12] Thus, again, the Indian system of the Yugas or ages of the world presents many features which most forcibly remind us of the Euphratean scheme, and a Mahâ-yuga is merely the Euphratean period of 432,000 years intensified by being multiplied by 10. Again, the Iranian stellar host is said to be 6,480,000 in number,[13] that is to say, $4{,}320{,}000 + 6000 \times 360$ ($= 2{,}160{,}000$), or $432{,}000 \times 15$, *i.e.*, the number of a Mahâ-yuga and a half of years. All these numbers appear to be connected in origin, and are in no instance arbitrary, the larger amounts being intensifications of the smaller.

Lastly, through the kindness of M. Clermont-Ganneau, the eminent archæologist, I can conclude with a notice of a Palestinian circle of late times, which shows most strongly Euphratean influence, and in which by a very peculiar arrangement are expressed, directly or indirectly, circles of 12, 60, 120, 240 and 360 divisions or degrees. M. Clermont-Ganneau says:—

'Je me suis rappelé un curieux monument que je me

4 Maspero, *Dawn of Civilization*, Eng. edit. p. 773.

5 *Imperial Dict.* in voc. Sexagesimal.

6 Vide Bezold, *Cat. of the Cun. Tabs. of the Kouyunjik Col. of the Brit. Mus.* i. 24.

7 Hence the remark of Pliny concerning Belus, 'Inventor hic fuit sideralis scientiæ' (*Hist. Nat.* vi. 36).

8 *W. A. I.* III. lii. No 3, Rev. l. 6.

9 Ap Pliny, *Hist. Nat.* vii. 56.

10 Ad Aristot. *Peri Ouranou*, 475 B.

11 Pliny, *Hist. Nat.* vii. 57.

12 Vide *Bundahish*, xxxiv.

13 *Bundahish*, ii. 5.

permets de vous signaler, et dont l'interpretation rationelle est encore à trouver. C'est un grand circle executé en mosaïque dans un pavement antique à El-Husn, dans la Palestine trans-jordanique. Il est d'époque relativement basse peut-être byzantine.'

After briefly describing this monument, and referring specially to the fact that the number 110 had evidently been designedly omitted, he adds: 'Je livre ce petit problém à votre sagacité.' I append a copy of the circle of El-Husn, and, following M. Clermont-Ganneau's example,

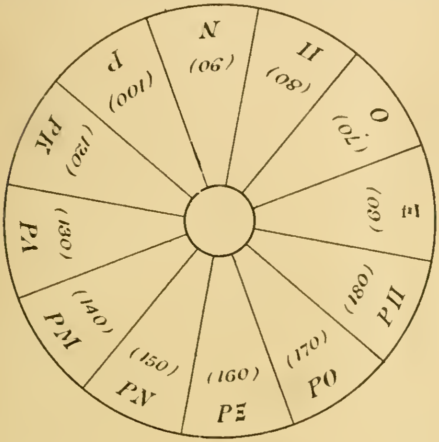


Fig. 2.—The Circle of El-Husn.

have inserted in brackets the numerical values of the Greek letters. As every division of a circle must, either expressly or by implication, begin with 1 and proceed 2, 3, etc., and as the numbers in this circle are not consecutive but range from 60 to 180, advancing by tens, except in the instance of 110, which is omitted, it is evident that two or more divisions of the circle are here shown in combination. In the abstract, a circle divided into 12 segments could be accommodated to the representation of 60, 120, 240, 360 or 480 parts (degrees), inasmuch as these several numbers are all divisible by 12. We have seen that two or more divisions of the circle must be shown by the Circle of El-Husn; and, as only 12 numbers were to be used, the problem before the circle-maker was how to express as many divisions of the circle as possible with these materials. The segments themselves showed the number 12, and the single number 60 sufficed to show by implication the division of the circle into 60°, commencing with Sec. PП—5°, PO—10°, and so on. A lower number than 60 could not have been used, (1) on account of economy in numbers, there being only altogether 12 numbers available to express all the ideas; and (2) because in a circle of 60° only, each segment must have been 5°, and such a segment would have prevented the harmonious expression of the other numerical circles. Hence the circle begins with 60°.

Now, had the numbers proceeded from 60 by increase of 10 without any omission, the total of the circle would have been 170°, an amount altogether inadmissible in any division of the circle. One decade (110) is therefore omitted, and at such a place as to bring 120 opposite 60, each on the line of one half of the circle. The 60, therefore, also represents the half of a circle of 120°, which latter is shown by commencing with PA—10°, PM—20°, and so on. Similarly, the 120 suggests the half of a circle of 240°, and the 180, which is also arranged to fall at the half circle, the half of a circle of 360°. Thus, the circle of El-Husn, by the use of only 12 numbers, expresses circles of 12, 60, 120, 240 and 360 degrees.

Such, then, are the Euphratean divisions of the circle which have come down to us, and thus do Euphratean concepts and principles connected with it still rule our world of to-day.

ASTRONOMY WITHOUT A TELESCOPE.

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

XVII.—STARS BY DAYLIGHT; AND THE SUM OF STARLIGHT.

Are the stars visible to ordinary sight in the daytime? There is a widespread tradition that they are; that if an observer places himself at the bottom of any deep shaft—as of a mine, a well, or a factory chimney—which may shut off scattered light and reduce the area of sky illumination acting on the retina, he will be able to discern the brighter stars without difficulty. The tradition is one of a respectable antiquity, for Aristotle refers to persons seeing stars in daylight when looking out from caverns or subterranean reservoirs, and Pliny ascribes to deep wells a similar power of rendering visible the stars the light of which would otherwise be lost in the overpowering splendour of the solar rays.

The tradition, well founded or not, has often been adopted for literary effect. It seems almost sacrilegious to hint that no star known to astronomers could have shone down unceasingly upon poor Stephen Blackpool during his seven days and nights of agony at the bottom of the Old Hell Shaft; that at best he could only have caught a glimpse of it for a few minutes in each twenty-four hours as it passed across the zenith. Dickens indeed does not absolutely say that Stephen watched the star by daylight. It is only a natural inference from his description; but Kipling adopts the tradition in its extremest form when he writes of:

"The gorge that shows the stars at noonday clear."

But is the tradition true? Of course everyone knows that Venus from time to time may be seen even at high noon; but then Venus at her brightest is many times over brighter than Sirius. Then, again, the assistance of a telescope enables the brighter stars to be discerned at midday; but the telescope not only directs the eye and greatly limits the area from which the skylight reaches the observer, but it enormously increases the brightness of the star relative to that sky illumination. The naked-eye observation of true stars in full sunlight stands in quite a different category.

Humboldt, who was much interested in the question, repeatedly tried the experiment in mines, both in Siberia and in America, and not only failed himself ever to detect a star, but never came across anyone who had succeeded. Much more recently an American astronomer set up a tube for the express purpose of seeing the Pleiades by daylight, also with no effect. It has been supposed that Flamsteed, the first Astronomer Royal, sank a well at Greenwich Observatory for the purpose of observing Gamma Draconis, the zenith star of Greenwich, in this manner. The existence of the well is undoubted, though Sir George Airy, the late Astronomer Royal, was unable to find it, but Flamsteed marks it on more than one of his plans of the Observatory, and there is a drawing extant of the well itself, showing the spiral staircase that ran down it. But its purpose seems to have been, not to have furnished the means of observing the star with the naked eye, but to enable the observer to measure as accurately as possible the distance of the star from the true zenith at the moment of transit.

Sir John Herschel mentions a case, which he considers as satisfactory evidence, of an optician who stated that the earliest circumstance that drew his attention to astronomy "was the regular appearance at a certain hour for several successive days, of a considerable star through the shaft of a chimney." This, it will be noticed, is second-hand evidence. I have never been able to obtain evidence even so direct as this myself, though I have met several persons who felt quite confident that they had seen stars by daylight on looking up the shaft of a mine, or that "some one had told them he had done so."

But the value of such indefinite statements is *nil*. I have met evidence more direct and explicit in support of that favourite legend due to the fertile imagination of the Emperor Jahangir, of the Indian juggler who threw a rope into the air and climbed up it, to disappear at its top into space—a legend which still makes periodic reappearances, and finds not a few devout believers. But direct, first-hand, scientific testimony of an observer who has been enabled by the use of a shaft to detect stars with the naked eye at midday is still to seek. By scientific testimony, I mean the record of the day, hour and minute when the star was seen, the latitude of the place, the depth of the shaft, the breadth of its mouth—the numerical elements, in a word, which are necessary to give value to the observations. There must be not a few of the many who take an interest in astronomy to whom the means for making such an observation are available, and who, if they would take the trouble, could report, "I have seen such a star at such a time," or, "I have watched for such a star at the time of its transit across the zenith on so many occasions, when the sky was clear, and could see nothing." Such observations would set the question at rest whichever way they tended; but what are wanted, here as elsewhere, are definite observations, carefully made, fully and systematically recorded, not vague, second-hand impressions which are perfectly valueless as evidence.

Whether or no the use of a shaft to diminish the effect of sky illumination, and so to render the stars visible by daylight is practicable, it suggests a method for dealing with what Prof. Newcomb in a recent paper has justly described "as among the most important fundamental constants of astrophysics," namely, the value of the total light of all the stars. In the paper* alluded to, Prof. Newcomb points out that the "total amount of light received from all the stars may serve as a control on theories on the structure of the universe, because the amount of light resulting from any theory should agree with the observed amount. It is also a quantity which we must regard as remaining constant from age to age." Yet, strangely enough, few if any attempts have been made to determine it. One of these was made by Mr. Gavin J. Burns,† his method being to compare the brightness of the spurious disc of a star seen out of focus in a telescope with the light of the sky. The eyepiece of the telescope was pushed in and out until the brightness of the spurious disc seemed to correspond with that of the sky. Prof. Newcomb, two years later, adopted several plans, his purpose being a twofold one—first to determine the relative brightness of different portions of the sky, and next to express the brightnesses of given units of surfaces in terms of starlight, from whence in turn the brightness of the whole heavens in terms of starlight may be inferred.

* *Astrophysical Journal*, December, 1901.

† *Journal Brit. Ass. Asc.*, Vol. XII., p. 212.

Prof. Newcomb's first plan was to use a small tube, the length of which he could easily vary, the ends of the tube being covered with caps having apertures of varying diameters, and to measure therewith the smallest area of sky which was certainly visible to him. A second method was by means of small mirrors arranged so as to enable different regions of the sky to be compared directly. Roughly speaking, the Galaxy appeared, surface for surface, about twice as bright as the sky outside it.

For the determination of the brightness of different areas in terms of starlight a concave lens was used, so as to spread out the image of the star into a disc, and the brightness of the expanded image was cut down by means of an absorbing glass to that of the sky. The results appeared to point to a value for the total starlight of over 600 to 800 stars of magnitude 0, whilst Mr. Gavin Burns, by different methods, fixed the value at about 400 stars for one hemisphere, or 800 for the entire heavens. Both results, though more accordant than might have been expected, can only be regarded as first approximations, and there is abundant room for many other observers to follow these pioneers, and supplement their work.

One method for comparing the light of the sky in two different regions would be by means of some such simple apparatus as the following:—A tube, bent at right angles, should be fitted at the angle with a piece of card placed at 45° to either arm. The card should be painted a dead black all except a white cross in the centre. The observer should look down one arm, through a diaphragm about $\frac{1}{8}$ inch in diameter, and view the card, which would be illuminated by the light coming down the other arm, and the opening of which would be directed to some known region in the sky. This opening should be provided with a series of caps having apertures of different diameter, and the arm itself should be fitted with a draw tube, so that both the size of the opening and its distance from the card might be varied at will. The observer, having carefully set the tube in some given direction, would move the draw tube in or out, or vary the caps over the aperture, until the white cross on the cardboard in the angle could just be certainly discerned. The aperture, the length of the draw tube, and the part of the sky to which it is directed, must then be carefully recorded.

The rough altazimuth, described in the chapter on "Observations of the Sun,"* would prove a suitable mount for such an instrument. If used for this purpose its circles must be read, whilst, of course, the time of the observation should be taken, and the state of the sky noted. Necessarily, observations of this kind are only possible at stations far from the glare of towns, and on moonless nights of special clearness.

The observer might well begin his work with some such device as this, but in a field so nearly new there would be full scope for his best ingenuity and contrivance in improving on this beginning, and in arranging for better and exacter methods for dealing with the noble problem he had undertaken.

It must be noted that the result of these observations will give the sum of starlight + any other general source of illumination which may be present. It must be assumed that the observer is working far from the influence of any artificial lights, and that so far as he can ascertain there is absolutely no cloud or mist in the sky. But there still remains the question whether the general illumination of the sky does not vary from time to time. Thus, two observers of the very first rank, Mr. Denning and Mr. Backhouse, have recorded that in August, 1880, the sky was unusually light. It is clear that the sum total of

* KNOWLEDGE, 1900, June.

SOUTH.

NORTH.

THE "TRIPLE CAVE" IN AQUILA.

starlight cannot vary from time to time, and if the light of the sky is different on one occasion from that which it is on another, allowance, of course, being made for any annual variation, due to the Milky Way or some of the brighter constellations being in an especially favourable position, then this variation in luminosity must be due to some cause other than starlight. Over and above, therefore, the two very important researches (*a*) of the relative brightness of different portions of the heavens, and (*b*) of the total sum of starlight, there will come the question as to whether there is in addition any variable source of luminosity, and, if so, what are its nature and origin, and the laws and causes of its changes.

THE "TRIPLE CAVE" IN AQUILA.

By Dr. Max Wolf.

The writer discovered these very interesting dark structures in the Milky Way in Aquila on the 12th of July, 1891, using a Kranz 5-inch photographic doublet. Their discovery was published for the first time at the meeting of the Astronomische Gesellschaft at Munich in 1892. The broadest arm of the dark structure appears as if it were the nearest, and the smallest arm as if it were the furthest from the observer, so that it would seem to give a perspective view into space of the heavens in the Milky Way. But this is probably a mere illusion.

The accompanying plate is a reproduction of part of the original negative made with the worse of the two Brashear 16-inch portrait lenses. The plate taken with the better lens shows a defect in the centre of the structure, and is therefore not suitable for reproduction. A bubble in the glass of the negative from which the present reproduction is taken shows itself as a slight defect, but does not interfere with the representation of the dark structure, and the photograph seems therefore good enough for publication.

The broadest of the three "caves" is the most southerly. The co-ordinates of the middle "cave" are—

R.A. = 19h. 33m. Dec. = + 10° 35′ (1855·0).

The plates were exposed on July 19, 1901, for three and three-quarter hours. Scale, one degree equals about seven centimetres.

Heidelberg.

Letters.

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

VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I would like to add a word to the discussion raised by Mr. Maunder's interesting remarks on the visibility of Venus. I was stationed for some time in the remarkably fine air of Darjeeling, at an elevation of about 8000 feet. On any clear night when the Pleiades were high up I could see eleven stars without difficulty; I have glimpsed twelve. The dividing of ε Lyræ in that air was easy, though it is generally not so in England. And whenever Venus was fairly high up I could almost certainly pick her up within 5 minutes with the unaided eye, knowing only the general direction in which to look, and not using my equatorial as a guide. In this way I have seen her when crescented very near to overhead, and I entirely failed to trace the least vestige of her true shape. With a magnification of 3 the crescent was visible, but no more.

As to Jupiter's satellites, I cannot help thinking that, in a perfectly still clear air, with no glare, the outer area would be visible without optical aid if a fine wire were fixed up and used as an occulting bar—but I have not tried this. J. W. Meares.

Writers' Buildings, Calcutta.

THE SUPPOSED DISCOVERY OF ALUMINIUM 2000 YEARS AGO.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The following paragraph appeared in "Echoes of Science" in the *Globe* of August 19th, 1898:—

"The first discoverer of aluminium had the reward of genius. Pliny tells us that in the reign of Tiberius (41 B.C. to 37 A.D.) a worker in metals presented a beautiful metal cup resembling silver, but lighter, to the Emperor, who questioned him, and learned that he had extracted the new metal from clay. The secret, he said, was known but to himself and the gods. The sage Tiberius, reflecting that if this metal could be made from earth it would lower the price of silver and gold, decapitated the artificer in order that his secret might remain with the gods, and so deprived the world of a most useful metal for eighteen centuries."

It would interest many readers of Knowledge if some student of Pliny would state where in his works the account is to be found, and furnish a translation thereof.

That the metal of which the cup was formed was really aluminium appears possible from four circumstances:—(1) It was obtained from clay; (2) it resembled silver; (3) it was lighter than silver; (4) it was capable of being wrought into a vessel.

The question naturally occurs, How did the metallurgist of the first century obtain a metal, which in the twentieth century can only be extracted by processes totally unknown to the ancients, and which it is inconceivable that any individual worker among them could have accidentally hit upon? Modern methods of procuring aluminium are: (1) Chemical, involving the use of sodium or potassium; and (2) electrical. The contemporary of Tiberius cannot have knowingly isolated sodium or potassium, and then applied it to separate aluminium, though it is possible that sodium or potassium may have been liberated from some ingredient of a mixture in his retort or crucible, only to oust aluminium from some other ingredient. That his process was electrical is quite out of the question.

If Pliny's account actually refers to aluminium there must be some method of separating it which modern chemists have failed to light on, but which lay not very far outside of the range of ancient metallurgical knowledge. Cannot it be rediscovered by some chemist possessing a wide knowledge of the science, and who is at the same time well acquainted with the methods (many of them forgotten) adopted by ancient and mediæval workers? Such a process would probably go very far towards cheapening that most useful metal.

3rd July, 1902. John T. Kemp.

British Ornithological Notes.

Conducted by W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U.

Birds in Captivity.—The *Zoologist* for July contains a really valuable and extremely interesting article by Dr. A. G. Butler, in which he recounts his avicultural experiences for the past twenty years. He surveys in turn the postures, bowings, and dances of birds when courting, their songs, nest-building, sexual characters, and habits in confinement. It is difficult, from the mass of information which Dr. Butler has brought together, to select items for special comment, but his remarks on the precocious development of some birds seem particularly interesting. Thus he writes: "Some of the little Ploceid

Finches (such as *Amadina fasciata* and *Tæniopygia castanotis*) are in full adult plumage, and ready to breed when about six to eight weeks old; thus examples of the former, which left the nest in September, were breeding in October; and it is not uncommon for Zebra Finches (*T. castanotis*) to build and lay when eight weeks old."

The Racket-tailed Parrot.—The *Field*, July 12th, contains some interesting observations on the Racket-tailed Parrot (*Prioniturus platurus*), recently purchased by the Zoological Society. This is not only the first specimen of its kind acquired by the Society, but appears to be the first ever brought alive to Europe. If this bird lives through the next moult it will be interesting to watch whether the peculiar racket-shaped middle tail feathers, from which the bird takes its name, are natural growths, or artificially produced like the similar tail feathers of the Motmot.

White Stork Nesting in Kew Gardens.—The *Field*, August 2nd, contains a graphic description by Dr. Günther of the successful breeding of the White Stork, during the spring of this year, in the Royal Gardens at Kew. Twice before the now triumphant pair have essayed to rear a family, but their attempts proved abortive. This year, however, they succeeded. A low platform of sticks was erected between two elms, near the lake, and on this the birds built a nest of dried twigs. On the 14th April the first egg was laid, five days later a second was deposited, and this was followed by three others on alternate days. Of these five eggs, two were addled, and of the three chicks hatched but one now remains. Dr. Günther, in his article, draws special attention to two extremely interesting points. In the first place he writes that the young do not appear to have been fed in the orthodox fashion, inasmuch as according to the ornithological records the adults insert the beak in that of the nestling, and passes from the stomach a meal of half-digested food. According to the observations of the keeper the food was deposited on the edge of the nest, and taken by the young without the assistance of the parents. Secondly, he remarks that the rate of growth was at first very slow, at a month old the nestling was not larger than a duckling of the same age, and still downy; after this time growth was rapid.

White-fronted Goose Nesting in Captivity.—Mr. W. H. St. Quinton writes to the *Field* (July 19th) pointing out that Mr. Frohawk's letter of July 5th, and referred to in our August issue, is slightly incorrect, in so far as he states that the nesting of the White-fronted Goose in confinement at Blackheath constitutes the only authenticated instance. Mr. St. Quinton has a pair of these birds which successfully hatched out four goslings in 1900, and this year she again hatched four young.

Interesting Arrivals at the Zoo.—Three young Secretary Birds from Kordofan, presented by Col. Mahon, have just been placed in the eastern aviary. At present they are but in indifferent plumage, but it is to be hoped they will rapidly improve.

Mr. Harry Witherby *having now returned from Persia, all communications with reference to this column should be addressed to him at the Office of* Knowledge, 326, *High Holborn, London.*

NOTES.

Botanical.—*Byblis gigantea*, a plant of considerable interest from Western Australia, is figured in the July number of the *Botanical Magazine.* In Bentham & Hooker's *Genera Plantarum* the genus is referred to the Droseraceæ, from which it differs in several important characters, including the simple style and the two-celled ovary. The late Mr. Bentham, in the *Flora Australiensis*, points out its resemblance to *Cheiranthera*, an Australian genus of Pittosporaceæ; and Mr. F. X. Lang, in a long paper published in *Flora* for 1901, states that *Byblis* approaches most nearly *Polypompholyx* in Lentibulariaceæ. He notes that its glands do not agree in structure with those of Droseraceæ, but do closely with those of some Lentibulariaceæ; also that the corolla of *Byblis* is gamopetalous. He attaches much importance to this character, but Sir J. D. Hooker finds that the petals are obscurely coherent at the very base, and even there only in a young state. The plant he considers requires further investigation, and meanwhile prefers to leave the question as to its order unsettled.

Das Pflanzenreich, the great work now appearing under the editorship of Dr. Engler, of Berlin, has just reached the eleventh part, which consists of a monograph of the Marantaceæ by Prof. K. Schumann. Among the other orders already elaborated may be mentioned Aceraceæ, Monimiaceæ, Symplocaceæ, Myrsinaceæ, and Tropæolaceæ. The monograph of the Myrsinaceæ, by Prof. Mez, forms a volume of 437 pages. The need for such a work as this has been very pressing for many years, as the best work of the kind now in use—De Candolle's *Prodromus*—is considerably behind the times. By Dr. Engler himself, and under his direction, numerous important contributions have been made during the last ten years to our knowledge of the Flora of Tropical Africa. The *Monographieen Afrikanischen Pflanzen-Familien und-Gattungen* is a finely illustrated quarto, of which five parts have appeared, the last dealing with the Anonaceæ. If continued in its present form this work will almost rival in magnitude the *Flora Brasiliensis.* Engler's *Botanische Jahrbücher* contains in nearly every part some important paper on African botany. Belgian botanists are also devoting their attention to Tropical African plants, while in this country the *Flora of Tropical Africa*, edited by Sir W. T. Thiselton-Dyer, is making steady progress.—S. A. S.

Zoological.—The Zoological Society's menagerie has recently been enriched by the addition of a living example of the proboscis-monkey of Borneo, the first of its kind ever received in the gardens. Unfortunately the specimen, which is a male, is immature, so that it does not show the great development of the nose characteristic of the adults of that sex. Should it survive and grow to maturity, it will serve to correct the ordinary idea of the form of that appendage. For it is a somewhat curious coincidence that Dr. Jentink, in the *Notes of the Leyden Museum* for July, has just published a photograph taken from a living adult male of this monkey, which shows that the nose, in place of being narrow and projecting straight forwards, is spatulate and bent downwards so as to conceal the mouth in a full-face view.

Certain structures in the brain of marsupials form the subject of an important paper contributed by Prof. G. E. Smith to the *Proceedings* of the Royal Society. These serve to show that the "diprotodont" members of that group, such as kangaroos, phalangers, and wombats, differ markedly from their carnivorous "polyprotodont" relatives in this respect. The author also concludes that the full development of the so-called corpus callosum in the brain of the placental mammals has given them an advantage quite sufficient to account for the dominant position they have acquired in the world's fauna.

Two interesting new types of marine invertebrates, each known solely by a more or less damaged example, have recently been made known. The one is a swimming type of zoophyte, or hydroid polyp, from New Zealand, described by Dr. Dendy under the name of *Pelagohydra mirabilis* in the *Quarterly Journal of Microscopical Science*. For the description of the second, a new form of crinoid, or "stone-lily," naturalists are indebted to Messrs. Koehler and Bather. This form, which was dredged off the Canaries (not, as stated in the text, off the Azores) by the Prince of Monaco, is described in the *Mem. Soc. Zool. France* as *Gephyrocrinus grimaldi*. Both forms constitute new generic types.

In a paper contributed to the *Geological Magazine*, Dr. Andrews continues his account of the wonderful Tertiary vertebrate fauna of the Fayum district of Egypt. In that instalment he describes the skull of a "sea-cow," or sirenian, which he regards as generically distinct from all hitherto known types, and proposes to call *Eosiren libyca*; and likewise two additional forms of the Proboscidean genus *Moeritherium*.

Professor Noack, of Brunswick, has published in the *Zoologischer Anzeiger* for February last an account of the Mongolian wild horse (*Equus przevalskii*), based on the specimens obtained by Herr C. Hagenbeck, many of which are now living in the Duke of Bedford's park at Woburn. It appears that *taka* is the Mongolian name of these animals, which inhabit the district east of the Garchun oäsis, as well as the Zungarian desert, and the neighbouring mountains to a height of 7500 feet. They are now found in herds of fully a thousand strong, each led by an old stallion. Certain individual differences of colour noticeable in the herd brought to Europe Prof. Noack attributes to the different localities whence the specimens were obtained. The individuals from the open desert he describes as light greyish yellow fawn in colour, while those from the lower mountains are light yellowish brown, and those from higher elevations, dark yellowish rufous. In the lightest coloured individuals the muzzle is white, in the darker ones bright yellow, and in the darkest rusty yellow. Prof. Noack is quite convinced of the specific distinctness of the Mongolian horse, alike from the now extinct tarpan of the Kirghiz steppes, and the domesticated or half-wild horses of Mongolia. He adds that no skins or skeletons of the tarpan, which was exterminated in 1876, appear to have been preserved in any museum.

In the same journal, Professor Noack describes as new a stag from Zungaria, of which specimens were brought to Europe by Herr Hagenbeck's expedition, under the name of *Cervus wachei*. He describes the antlers as wapiti-like at the base, but at the summit approximating to those of the rusine or rucervine groups. In the absence of figures it is difficult to form an opinion as to the affinities of this deer.

The bighorn sheep shot by Mr. J. Talbot Clifton in North Siberia, to which allusion has been previously made in these columns, has been presented by that gentleman to the Natural History Museum, where it is now exhibited in the pavilion at the end of the lower Mammal Gallery. Visitors to that part of the gallery will not fail to notice that the magnificent series of bison and buffaloes occupying the large case at the west end have been mounted upon artificial groundwork, with the very best results so far as appearances and general effect are concerned.

A theory has long been current that the skeletons of *Iguanodon* from the Wealden formation of Bernissart, which constitute one of the chief attractions of the Brussels Museum, were deposited in a narrow gorge cut through Carboniferous strata and subsequently filled up with materials of Wealden age. This theory M. de Pauw, the clever articulator of the Museum, demonstrates (*Mem. Soc. Hainaut*, May, 1902) to be founded on a misconception. The iguanodons, as a matter of fact, lived on the borders of a lake, where in due course they died and their bodies became buried in the mud. It is generally considered that these reptiles always walked in the upright position, but M. de Pauw believes that they went frequently on all fours, and commonly assumed this attitude when leaving the lake.

A prehistoric drawing on a slab of limestone found near Schaffhausen, together with fossil remains from the same locality, are regarded by Prof. T. Studer (*Denks. Schweiz. Nat. Ges.*, Vol. XXV.) as sufficient to indicate the existence during the Pleistocene period of the Kirghiz wild ass, or chiggetai, in Switzerland.

Notices of Books.

"Studies in Heterogenesis." By Dr. H. Charlton Bastian, F.R.S. Part II. Pp. 63—147 and xvii. Plates VI.—XI. (Williams & Norgate.) 7s. 6d.—Dr. Bastian is very candid as to the reception which the scientific world has given to his observations. The Royal Society of London, the Academies of Science at Paris and Berlin, and the Accademia dei Lincei of Rome will have none of them; so in the memoir before us, and the one which was published a few months ago, a statement of the case for heterogenesis is placed before students of biological science independently of scientific societies. In this position Dr. Bastian should be content to leave his heterodox conclusions as to the production of several kinds of organisms from one cell substance. He can scarcely expect zoologists to accept his interpretations, whatever they may think of his observations. He announces that he has "witnessed on very many occasions the stages of this remarkable transformation of the contents of a Rotifer's egg into a Ciliated Infusorium." To apply strictly scientific tests to each stage of observation involved in this conclusion would take months of investigation, and there are so many *à priori* reasons against its validity, that zoologists are justified in hesitating to accept Dr. Bastian's views until they have the opportunity to make their own observations and analyse his methods of procedure. There are still people who believe the earth is shaped like a Cheddar cheese, and they can bring forward evidence apparently in support of this theory. Dr. Bastian would find it difficult to state observations which completely dispose of their conclusions; and biologists are in much the same position in relation to his work. Or shall we compare him to a Galileo who has seen new worlds and desires others to look for themselves and be convinced of their reality?

"Plant Relations: A First Book of Botany." By John M. Coulter, A.M., PH.D. Second Edition. Revised. Pp. ix. and 266; and "Plant Structures: A Second Book of Botany." By the same author. Pp. ix. and 348. Both illustrated. (London: Hirschfeld Bros. 1902.) Each 6s. net.—The number of botanical text-books published in this country and America within the last few years must almost create some perplexity in the minds of students and teachers in selecting one most suitable for their purpose. Professor Coulter, who has had considerable experience as a teacher, and has written treatises on nearly every branch of botany, might be expected to be especially well equipped for the production of a text-book, and no doubt can exist as to the excellence of those now under our notice. Lucidly written, beautifully and copiously illustrated, the works cannot fail to interest and teach all who may use them, and it is with pleasure that we recommend both volumes to our readers. The first edition of "Plant Relations" was issued in 1899 in New York. The present one, though practically the same in the first eleven chapters, has been much modified in the latter part dealing with plant societies, both in text and illustrations, as "this has been made necessary by the recent rapid development of the subject, by a larger field experience, and by the availability of more suitable illustrations." "Plant Structures," which forms the second part of the work, was originally published in 1899, and the copy before us, dated 1902, is, we presume, merely a reprint of the American edition. "Plant Relations" is devoted to the study of the natural history or, as it is often termed, the ecology of plants. It is calculated to represent work for a half year, and is independent of the second book, which deals chiefly with plant morphology, and represents work for another half year. The fourteen chapters of the first book begin with an introduction. Then follow chapters on foliage leaves, shoots, roots, etc. Chapter 7 deals wholly with flowers and insects, and chapter 9 with "the struggle for existence." The final portion of the book treats of plant societies (Hydrophytes, Xerophytes, and Mesophytes) which are determined by the conditions of water supply. Besides the morphology of plants, the second book includes a general review of the large systematic groups beginning with the Thallophytes and concluding with the Compositæ, proceeding according to the arrangement of Engler and Prantl. This part contains a useful glossary and each is provided with a good index. Professor Coulter published a work in 1901, under the title of "Plant Studies," reviewed in Knowledge, 1901, p. 233, which is based on the works before us. His books, by reason of their accuracy, freshness and originality, will doubtlessly be widely used by American students of botany, and only need to be known to become popular in this country.

"Mosquito Brigades and How to Organize them." By Ronald Ross, F.R.C.S. (Philip & Son.) 3s. net. Few modern discoveries have appealed more strongly to the popular mind than that of the part taken by mosquitoes in spreading disease, and Major Ross's leading share in this discovery is known to all. In this handy little volume he shows how practical use can be made of the knowledge that we have gained by organizing brigades of men whose work shall be the extermination as far as possible of mosquitoes in the neighbourhood of populous tropical cities and settlements. The chief means suggested is to drain stagnant pools and ditches in which Anopheles breeds, and to clear away useless vessels of dirty-water which harbour the larvæ of Culex. This is a surer means of destruction than to cut the grubs off from the air supply by the application of a film of oil to the water surface. The book is essentially practical, and the record of what has been done under the author's leadership in Sierra Leone shows how much benefit may be expected if the subject be earnestly taken up by those in authority. When we consider that the parasite causing malarial fever is absolutely dependent for its continuance on mosquitoes of the genus Anopheles, and those causing yellow fever and elephantiasis on mosquitoes of the genus Culex, and that both these genera depend on stagnant water as a breeding-place for their larvæ, we cannot fail to subscribe to Major Ross's "first law of tropical sanitation, namely, *no stagnant water*." These "Mosquito Brigades" are proposed as voluntary organizations where the local authorities will not take the matter up. Unfortunately, Major Ross has to complain of the apathy of those in authority, and their frequent unwillingness to carry out the practical measures of prevention, so surely indicated by his researches. In this connection one remark of his may be applied to other things besides mosquito-extermination:—"It is disgraceful that in scientific matters concerned with the life and death of thousands, scientific men should be so absolutely subordinated to unscientific men."

"Report of S. P. Langley, Secretary of the Smithsonian Institution, for the Year ending June 30th, 1901." Pp. 140. (Washington. 1901.)—In this report Dr. Langley surveys the work done between June, 1900, and June, 1901, by the United States National Museum, the Bureau of American Ethnology, the International Exchanges, the National Zoological Park, and the Astrophysical Observatory—all these departments being under the direction of the Smithsonian Institution. He gives a general account of the affairs of the Institution and its bureaus, and this is supplemented by more detailed statements by the officers in direct charge of the different branches of the work. The field surveyed is so vast that only a brief reference to some parts of it is here possible. A number of investigations are being carried on in connection with the Hodgkins Fund, among them being the relation between light and electricity, by Dr. V. Schumann; air currents at various altitudes, by Dr. A. Lawrence Rotch; and a study of air currents in relation to mechanical flight and ventilation, by means of chrono-photography, by Dr. Marey. In the National Museum Dr. Langley has had a children's room arranged. The room itself has been made attractive by a careful choice of colour and design in the decoration of the walls and ceilings, embodying illustrations of the life of animals and plants. The objects displayed in the room include cages of living birds, aquaria with living fishes, and cases filled with those things which interest children even of larger growth. The National Zoological Park was established with the view of preserving rare American animals from extinction by keeping them so far as possible in their natural surroundings; but though the aim is admirable, the funds granted by Congress are insufficient to carry out the scheme. In the report on the Astrophysical Observatory, reference is made to the eclipse expedition to Sumatra in May, 1901, which, unfortunately was unsuccessful on account of bad weather during the eclipse. Referring to the bolometer, Dr. Langley says that his instrument is now so sensitive that it will recognise a change of temperature less than one one-hundred-millionth of a degree. Many other subjects are mentioned, but we are unable to refer to them, though in common with other workers in the realm of nature we highly appreciate the contributions to knowledge made under the direction of the Smithsonian Institution, and the generous spirit with which the results are made available to the whole scientific world.

"Essays in Historical Chemistry." By Dr. T. E. Thorpe, C.B., F.R.S. Pp. xii., 582. (Macmillan.) 12s. net.—There are certain books which should be found in the library of every institution where science is taught, and this is one of them. Nothing is more inspiring to a student of science than a luminous account of the works of investigators who have contributed to the sum of natural knowledge; and we have in the present volume a survey of this character, in so far as it concerns chemistry. Dr. Thorpe has a facile pen, and a keen sense for interesting personal characteristics and essential points of progress. His essays represent presidential addresses, lectures, and contributions to various publications, and each one is a pleasure to read. The pioneers whose works are described are Boyle, Priestley, Scheele, Cavendish, Watt, Lavoisier, Faraday, Graham, Wöhler, Dumas, Kopp, Victor Meyer, Mendeléeff, and Cannizarro, while others are dealt with in accounts of progress made during various epochs. In this series of sketches we have the fundamental facts concerning the development of chemical science presented in their most interesting form; the masters are seen, as it were, in their laboratories, and the influence of each upon the progress of chemistry can be discerned. It is an inspiring story—this record of work carried on with the sole desire to obtain new knowledge of chemical compounds and changes—and the student of science who reads it should be proud that he is following in the path of those who have worked with so noble a purpose. Emoluments may be meagre and honours few, as judged by the world's standards, but a life devoted to the investigation of natural processes of any kind is sufficient unto itself.

"A Laboratory Course in Plant Physiology, especially as a Basis for Ecology." By W. F. Ganong, Ph.D. (New York: Holt. Sold in England by G. Bell & Sons.) Price 5s.—This is essentially a book for the teacher and advanced student of botany. Prof. Ganong's "Teaching Botanist" appeared in 1899, and was received with well-merited favour. That work was intended for the student of the first year, being a synopsis of the subject to those who follow it no farther, and a foundation for higher work to those who do. The second and third years should be devoted, according to Prof. Ganong, to courses in morphology with correlated ecology, cellular anatomy, particularly of the higher plants, with cytology and embryology, while the present work, "a practicum in physiology," should guide the fourth year's course. To get through it in one year it is requisite that the student should work each week about eight hours in the laboratory, with one lecture and one hour devoted to criticism of experiments and comparison of results. The first part of the book contains a description of the method to be followed and of the equipment necessary, and is directed chiefly to the teacher. Part II. is an Outline of a Course in Experimental Plant Physiology, made up of two divisions—(1) The Structure and Properties of Protoplasm, and (2) The Physiological Operations of Plants. The interrogative form is adopted, and following each question are suggestions as to the method to be used in answering it. Fifty-eight experiments for the solution of some of the questions are described, often with the aid of good figures. The numerous references to important literature affecting the subject will be of great value to those who have access to a good botanical library. The favoured students who have ample time and the use of the rather costly equipment to undertake such a course in practical plant physiology will, we have no hesitation in saying, find Prof. Ganong's little book a competent and trustworthy guide.

"THE SCIENCE OF MECHANICS." By Dr. Ernest Mach. Translated from the German by T. G. McCormack. Second English edition. Pp. xix. and 605. (Kegan Paul.) 9s. 6d. net. Illustrated.—No work in existence contains such a philosophical and inspiring account of the principles of mechanics in relation to their development as Prof. Mach's, rendered into fluent English by Mr. T. G. McCormack. The student of physical science who obtains from this book his concepts concerning the motions and equilibrium of masses is to be congratulated. Mechanics is not treated as a collection of problems having no connection with one another or with anything real in nature, but as one of the physical sciences. To the student familiar with the arid specifications of the principles of statics as expressed and illustrated in text-books in general, the treatment of the same subject by Prof. Mach comes as a revelation. The long chapter on dynamics is of especial interest to students of astronomy; the remaining chapters deal with the application of the principles of mechanics and the deductive development of the science, the formal development of mechanics, and the relations of mechanics to physics and physiology. To this new edition of what is everywhere regarded as a scientific classic, an appendix of eighty pages has been added, containing Prof. Mach's supplementary remarks upon various parts of the text. For its logic, history, and scientific scope, we commend the book most heartily to all serious students of matter and motion.

"DYNAMIC ASPECTS OF NUTRITION AND HEREDITY." By Frank Horridge. Pp. xiv., 175. (Baillière, Tindall & Cox.) 5s. net.—The titles of the three chapters of this book are "The Active Forces of Living Organisms," "The Spinal Cord and the Functions of the Cerebellum," and "Heredity." No useful purpose would be served by either describing or criticising the author's material or conclusions. Suffice it to say that an endeavour is made to connect physical and nervous effects and phenomena. Preventive and curative medicine are shown to depend for their results upon movements in the ether, and the cerebellum is regarded as a reinforcing organ to the nervous system. Lovers of speculative science may discover some ideas to interest them, but critical students will find the book a weariness of the flesh.

BOOKS RECEIVED.

The Relation of Science to Art. By Sir Samuel Wilks, Bart., M.D., LL.D., F.R.S. (Hampstead: Sydney C. Mayle.) 6d.

Manual of Astronomy. By Charles A. Young, PH.D., LL.D. (Ginn & Co.) Illustrated. 10s. 6d.

Animal Forms. By David S. Jordan, M.S., M.D., PH.D., LL.D., and Harold Heath, PH.D. (Hirschfeld.) Illustrated. 6s. net.

Elementary Principles of Chemistry. By A. V. E. Young. (Hirschfeld.) Illustrated. 5s. net.

Elements of Physics. By C. Hanford Henderson, PH.D., and John F. Woodhull, PH.D. (Hirschfeld.) Illustrated. 5s. net.

Early Life of the Young Cuckoo. By W. Percival Westell, M.B O.U. (Thomas Burleigh.) Illustrated. 1s. net.

European Fungus Flora Agaricaceæ. By George Massee, F.L.S. (Duckworth & Co.) 6s. net.

Analysis of English History. By W. C. Pearce and Dr. S. Hague, LL.B. Revised by W. F. Baugust. (Murby.) 1s.

Principles of Simple Photography. By Fred. W. Sparrow, R.N. (Hazell, Watson & Viney.) Illustrated. 1s. net.

Preparatory Lessons in Chemistry. By Henry W. Hill. (Allman & Son.) Illustrated. 1s.

Macaulay's Lays—Horatius, Lake Regillus, Armada and Ivry. Edited by W. J. Addis, B.A. (Allman & Son.) 1s.

Aërial Navigation. By Frederick Walker, C.E. (Crosby Lockwood.) Illustrated. 7s. 6d. net.

The Mill on the Floss. By George Eliot. (Ward, Lock.) 1s. 6d.

Electric Wiring. By W. C. Clinton, B.SC. (Murray.) Illustrated. 1s. 6d.

Report of the Yellow Fever Expedition to Parà (Liverpool School of Tropical Medicine—Memoir VII.). By H. E. Durham. (Longmans.) 7s. 6d.

Experiments in Aerodynamics. By S. P. Langley. (Washington: Smithsonian Institution.)

Memorias y Revista de la Sociedad Cientifica "Antonio Alzate." Nos. 4 and 5 and 6. (Mexico: Imprenta del Gobierno en el ex-Arzobispado.)

New Phytologist. Vol. I., No. 7. Monthly. 1s. 6d.

Board of Education—Supplementary Regulations for Secondary Day Schools and for Evening Schools (From 1st August, 1902, to 31st July, 1903). (Eyre & Spottiswoode.) 4d.

Eastern Uganda—an Ethnological Survey. By C. W. Hobley, ASSOC.M.INST.C.E. (Anthropological Institute.)

Ross Bird-Stalker. By Charles Dixon. (Ross Ld.) Illustrated. 6d.

Orchard and Bush-Fruit Pests and How to Combat Them. By Cecil Warburton, M.A., F.Z.S. (Murray.) Illustrated. 6d.

Bi-literal Cypher of Francis Bacon. Replies to Criticisms. By Elizabeth Wells Gallup. (Gay & Bird.)

ARCTIC OCEANOGRAPHY.*

THE truth of the old proverb, "It is the unexpected that happens," is seldom more forcibly illustrated than by this volume. When Dr. Nansen prepared for his adventurous voyage, against the advice of all whose experience of arctic expeditions entitled them to form an opinion, he expected to be carried in the drifting ice across a comparatively shallow sea, and the provision of oceanographical instruments and gear was made in this belief. He carried out his programme to the letter as far as the surface drift was concerned, but he discovered too late that the Polar Sea was one of the deepest instead of one of the shallowest of the oceanic areas, and research in its depths was only possible by means of gear made or adapted on board. It was naturally a great disappointment to Dr. Nansen to find that his most valuable results were shorn of their completeness by the want of a few thousand fathoms of wire. He realised, too, that when working in the deep sea from the solid surface of the ice a far higher degree of accuracy was possible in oceanographical observations than the vicissitudes of a tossing ship, often under the command of an impatient officer, had allowed his predecessors to dream of. On his return he proceeded to devise and test instruments of high precision, and the result has been to turn Dr. Nansen from a biologist into a physical oceanographer. We may consequently expect developments of a very interesting kind from the Laboratory of the International Council for the Study of the Sea, which is shortly to be opened at Christiana under his direction.

After a full confession of the incompleteness of the "Fram's" oceanographical work in the preface to the first memoir, "On the Oceanography of the North Polar Basin," Dr. Nansen goes on to describe and criticise his instruments, "nothing extenuating" as to their defects, to tabulate his observations with a running commentary as to their probable errors, and finally to deduce his conclusions with a caution, and at the same time an independence and originality which inspire confidence and respect. There is a good deal in this great volume to nourish discussion, and it might not be difficult to combat some of the more theoretical conclusions, but in a short account of such a harvest from a field hitherto untrodden and untouched it is better to pay attention only to the heap of beaten-out grain.

It is hardly necessary to recapitulate the route of the "Fram," but nevertheless there may be some readers who will not resent a few lines of orientation. The ship left Vardö on July 21st, 1893, passed through the Yugor Strait early in August, coasted the Yalmal peninsula, rounded

* "The Norwegian North Polar Expedition, 1893-1896. Scientific Results." Edited by Fridtjof Nansen. Vol. III. Published by the Fridtjof Nansen Fund for the Advancement of Science. (London: Longmans, Green & Co.) 1902.

Cape Chelyuskin, the most northerly point of Asia, on September 11th, and entered the ice north of the New Siberian Islands on September 22nd, in 78° 50′ N. From this time she drifted with the ice, being about 79° N., 138° E. on 1st January, 1894, in 83½° N., 102° E. on 1st January, 1895, in almost 86° N., 67° E. (her farthest north) on 15th November, in 85¼° N., 47° E. on 1st January, 1896, and in the middle of July she broke out of the ice in 84° N., 15° E., to the north of Spitsbergen. Along the whole of this extensive route, which was traversed by the "Fram" in many devious loops, observations were made at frequent intervals by lowering thermometers and water-bottles through openings broken in the ice. At least nine observations were made at depths of 1000 fathoms or more, and were it not for the risk of breaking the only available sounding-line, which was wearing thin with use, many others would have been obtained.

In discussing the instruments and observations, Dr. Nansen has much to say as to their corrections and the probable errors of observation, and if he errs in this matter it is by the perhaps unnecessary refinement of some corrections. These corrections also were in many cases suggested by laboratory work subsequent to the return of the expedition, and if they had been thought of when the observations were made, some little advantage might have resulted. They will, however, bear good fruit in subsequent expeditions. As they stand, Dr. Nansen's observations are at least as accurate and trustworthy as the best work of his predecessors; but there is no doubt that in the conditions of the polar seas, with a very small range of temperature, and with solid ice to work from, far greater refinements in observational methods are possible than in the open ocean.

The primary object of investigating the temperature and salinity of the water was to throw light on the circulation of that part of the ocean. The observed facts were that a layer of cold and comparatively fresh water, probably due to the great rivers of Northern Asia, covered the surface of the Polar Basin to a depth of about 100 fathoms. Beneath this a distinctly warmer and much salter body of water was found, its high salinity being maintained to the bottom, while its temperature came to a maximum at a depth of about 200 fathoms, from which plane it falls gradually to a minimum near the bottom, but never becomes so cold as the surface layer. This appears to be Atlantic water in course of cooling down, and the very slight rise of temperature observed in it at the bottom is attributed to the influence of the internal heat of the earth.

The curves of temperature, salinity, density *in situ*, and the isosteres, or lines of specific volume calculated according to Bjerknes' method, afford a basis for estimating the forces tending to produce circulation in the water, and taking all these into account Dr. Nansen comes to the following conclusion.

There are at least four systems of currents in a vertical section along the route of the "Fram." (1) A surface current of low salinity (29 to 32 per mille) about 20 metres deep running towards the north-west and west. (2) An underlying slow current of high salinity and very low temperature running in a different direction and consisting of surface water from other parts of the Arctic Sea. (3) A current of relatively warm water of high salinity (35·1 to 35·3 per mille) coming from the Gulf Stream, west of Spitsbergen, and running towards the east at depths below 250 metres. (4) An extremely slow current of colder water filling the deepest part of the basin (below 1000 metres), forming the densest part of the preceding current which has been cooled down and sunk. In the mass of this very slow-moving current which may not renew the water in the Polar Basin once in several centuries, Dr. Nansen believes that the internal heat of the earth may give rise to a system of vertical circulation.

The whole of this difficult subject is discussed at great length, but we cannot say that the difficulties which present themselves to our mind are removed. Of these the chief is why warm Atlantic water penetrating the Polar Basin beneath a sheet of very cold water of low salinity should cool more rapidly downward than upward. There must, we should think, be a system of oblique circulation to produce this effect, such as might be produced by the wind.

In dealing with the surface current, the demonstration of the existence of which gave Dr. Nansen confidence in his plan of a drift-voyage, we are on surer ground. The fact that the "Fram" followed the route which she was expected to traverse of course proved the main fact that there was a drift of ice from the Siberian towards the Greenland side of the basin. It did not, however, prove whether the ice was simply drifted over by the wind, or carried along by a definite ocean current irrespective of the wind. Wind-drift was, of course, a very powerful factor, as the curious tangled track of the "Fram" clearly proves, but when the influence of the wind was eliminated by considerable periods during which the wind resultant was zero, a residual drift due to a permanent current was plainly visible. This permanent current had an average velocity of 0·73 nautical mile in 24 hours. That the permanent current was in the main independent of wind-drift appears from the fact that the mean rate of the wind-drift was only 0·52 nautical mile in 24 hours, and its direction was substantially different. The primary cause of the permanent surface current is considered to be the volume of fresh water poured in by the Siberian rivers.

In his discussion of the circulation of water in the Polar Basin, Dr. Nansen makes very large use of the deviation due to the rotation of the earth, as it affects vertical as well as horizontal movements. He employs this hypothesis in constructing a scheme of the probable circulation of the unknown parts of the North Polar area, but points out the uncertainty arising from our ignorance of the configuration of the American margin of the basin, which must have a great influence on the movement of the waters.

Some remarkable relationships are brought out by a comparison of the oceanographical conditions of the North Polar Basin and of the Norwegian Sea. Contradictory as it may appear to our natural opinion, the bottom water in the North Polar Basin is warmer and salter than that in the Norwegian Sea at the same depth. Thus, between Norway and Iceland, bottom temperatures of − 1°·1 C. or lower are obtained, while the coldest bottom water met with by the "Fram" was only − 0°·87 C. Hence it is necessary to assume that the basins of the two seas are separated by a sub-oceanic ridge extending from Spitsbergen to Greenland. The cold and comparatively fresh East Greenland and East Iceland polar currents are, in Dr. Nansen's opinion, simply the outflow of the surface water of the Arctic Sea, consisting of Atlantic water freshened by the Siberian rivers, and containing a quite insignificant proportion of fresh water due to melting ice.

Much work must still be done in the northern seas before all the problems are satisfactorily solved, but the outcome of the "Fram's" researches is to give a certain basis of fact from which a multitude of fresh ideas will spring, each demanding new and exact observations before it can be settled. We would much like to see the drift of the "Fram" repeated, say from Bering Strait, in a vessel fully equipped for oceanographical work, and we would venture to urge that this should be undertaken even in face of the incomprehensible fate which has hitherto decreed that the first attempt at a new route or method of exploration in the Arctic regions is always more successful than any subsequent endeavour on the same lines.

Dr. Nansen has something to say with regard to the interesting question of the climate of the Arctic regions in past geological periods. He points out that the superficial layer of light cold water exercises a cooling influence on the atmosphere in several ways. If any change had occurred in the courses of the great Siberian and American rivers, diverting their water from the Polar Basin, or any change in the configuration or depth of the basin itself, the cold surface layer might also have disappeared. A raising of the sea-level by 1000 metres would admit a far greater volume of warm Atlantic water and mitigate the climate to a very marked degree, a fall of the sea-level by even 500 metres would produce a still more pronounced effect in the opposite direction, and there is evidence that such changes have occurred in the past Thus Dr. Nansen's results afford fresh data for attacking the semi-fossil problem of the cause of glacial periods.

After the perusal of a memoir so full of new facts and far-reaching suggestions, we come as a sort of anti-climax to a paper on "Hydrometers and the Surface Tension of Liquids," which is included in the volume. The subject is of importance, because hydrometers have had much to do with ascertaining the facts as to the salinity, not of the North Polar Basin alone, but of all parts of the ocean. It is a question full of difficulty, on which there exists a considerable literature, and about which controversies of some intensity have arisen. Dr. Nansen traces the bad reputation of the ordinary hydrometer to the capricious variations of surface tension in liquids which have been contaminated by any greasy substance, and he describes a series of experiments resulting in a method of skimming and cleansing the surface, which enables a hydrometer to be used with more certainty of a good result than was before considered possible. We believe that with care in the use of ungreased water-bottles, clean utensils, and frequently-washed hands, surface tension may not prove so formidable a variable as Dr. Nansen's experiments seem to suggest. However, there is no doubt that the use of the stemless or total immersion hydrometer recommended by Dr Nansen promises to simplify the labour, and to improve the accuracy of density determinations at sea. He proposes to employ a set of cylindrical hydrometers without stems, one of which, having a specific gravity very near that of the sample of water to be tested, is immersed in it, the containing jar being constructed with a vacuum jacket on Professor Dewar's principle. A delicate thermometer is also immersed in the water, and the temperature is raised or lowered by stirring with a closed glass tube containing ice, or a similar tube containing warm water, until the float is in exact equilibrium with the water. The only reading required is that of the temperature, as the weight, volume, and expansibility of the hydrometer have been previously ascertained.

There is still a great future before oceanography. Every year demonstrates more clearly the intimate relation between the temperature cf the sea surface and climate, and such works as this prove that the temperature of the sea surface can only be understood by the investigation of the conditions of the mass of the water at all depths. In some parts of his investigations Dr. Nansen introduces mathematical treatment, which is now fairly justified by the improved data available for discussion, and we would commend some of the problems touched upon to the tutors of Cambridge as not unworthy of their attention.

STUDIES IN THE BRITISH FLORA.

By R. Lloyd Praeger, B.A.

V.—ON AN IRISH BOG.

Leaving the county road, we strike down a bohereen—a "roadling," to use the English equivalent—towards where the brown edge of the peat bog rises a couple of fields away. On one side of the lane is a broad ditch of still brown peat water, which the sloping sunlight brightens to a rich amber. The patches of brown-leaved *Potamogeton coloratus* which grow below the surface harmonize well with the dominating tint of water and soil; and in startling contrast to these the light strikes on cloud-like masses of *Chara fragilis*, here quite free from limy incrustation, and vivid in their greenness. On the other hand, flat peaty meadows extend, full of Yellow-Rattle and *Agrostis vulgaris*. The Orchids like this ground, and amid the pink and red spikes of *O. maculata* and *incarnata*, we see the greeny white of *Habenaria chloroleuca* and *H. bifolia*, and the fragrant purple pyramids of *H conopsea.* More sparingly, in a drier spot, is a colony of the beautiful Bee Orchis (*Ophrys apifera*), and the little Frog Orchis (*H. viridis*). We pass to a flat expanse of almost bare peat, where *Agrostis vulgaris* and *Rumex Acetosella* are only just obtaining a hold, and *Senecio sylvaticus* shifts about season by season. This ground is used for drying and stacking the peat after it has been cut from the neighbouring bank. The cutting is done somewhat irregularly, and we surmount several successive steps, and rising some fifteen feet, find ourselves on the heathy surface of the bog. This portion has slipped and shrunk owing to the drainage induced by the turf-cutting; and while the Ling appears benefited by the change, most of the plants look starved, and the little pools are all dry. So we push upward and onward through the heath. Soon brilliant patches of Bog-moss, or *Sphagnum*—green, yellow and crimson—make their appearance, the surface pools are filled with water and fringed with Sundews, the cultivated land is lost to sight behind us. A couple of stunted Birches, the only break in the sky-line in front of us, give something to steer for. A Curlew rises with a loud whistle. We pause, as the bubbling water reminds us at every step that we are now beyond the influence of turf-cutting and drainage, to examine the flora at leisure.

The plants which form the vegetation here constitute a very distinct association; very homogeneous, too, though limited in variety. Wander as we will, we scarcely enlarge the plant-list formed in our minds by our first scrutinising glance. The dominating species, and the one which gives the general surface its appearance and colour, is the Ling, *Calluna Erica*. With it, in smaller quantity, is the Bell-heather, *Erica Tetralix*. The great green and red cushions of *Sphagnum* form a conspicuous feature. Two other ericaceous plants, *Andromeda Polifolia* and the Cranberry, *Vaccinium Oxycoccus*, appear to like the shelter and cool dampness which these mosses afford; their struggling stems wind far into the depths of the *Sphagnum*, while their leaves and flowers brighten its surface. Great grey cushions of a drier nature are formed here and there by another moss, *Rhacomitrium lanuginosum*; some of these rise three feet above the general surface of the bog. Almost as abundant as the Ling are two other plants, the beautiful little Bog Asphodel, *Narthecium ossifragum*, with its golden stars of blossom and Iris-like leaves, and the Club-rush *Scirpus cæspitosus*, growing in tufts with stiff radiating stems, like glorified pin-cushions. Both the Cotton-grasses, *Eriophorum angustifolium* and *E. vaginatum*, are here, though sparingly, and that quaint erect little plant, looking strangely out of place, is the Fir Club-moss, *Lycopodium Selago*. The oozy sinuous pools are filled with *Sphagnum*, and here and there with the Bog-bean, *Menyanthes trifoliata*; the edges of the pools are luxuriously cushioned with a variegated growth of *Sphagnum*, and these edges are the favourite haunt of two of those wonderful fly-devouring Sundews, *Drosera rotundifolia* and *D. anglica*. In the shallower pools, or on bare mud, the White Beak-rush, *Rhynchospora alba*, grows in tufts, and its farther-creeping relative, *R. fusca*, fills portions of the pools with an erect growth of bright green stems and brown inflorescence. These, with some subsidiary mosses and lichens, complete the flora of our bog.

The conditions under which this plant-group lives are remarkable. The spongy crust is perennially saturated with water, which circulates very slowly. In consequence the soil is badly aerated, and the plant-remains which form the crust do not become thoroughly oxidized, and soluble humus compounds remain in solution in the water. The plants can with difficulty absorb by their roots water charged with these substances, and thus it comes to pass that while the bog is physically very wet, physiologically it is very dry. In the midst of plenty the plants are actually starving. It is, indeed, a true case of

"Water, water everywhere,
Nor any drop to drink."

Exactly the same difficulty, it may be remarked, occurs in salt marshes, where the water is charged with sodium chloride. In both cases the plants meet it in the same way, by checking transpiration, and thus saving up the water which they absorb. Thus they assume characters similar to those displayed by plants of deserts and dry places—xerophytic characters, to return to a term which we have had occasion to use before. These are seen in the smallness of the leaves of the Heaths, for example, as well as in the curious backward-rolled character of their leaves, as well as of those of the Cranberry, Crowberry, etc. In other cases the leaves are protected by a thick impervious cuticle or skin, or by a close growth of hairs. Another peculiarity in the conditions under which the bog flora grows is that in the water-logged soil there are no bacteria present, which are so useful in breaking up the complicated nitrogenous compounds contained in the dead plant matter; hence nitrogen as a plant food is scarce. This may help to explain why the Sundews, which are essentially bog-plants, have hit upon the extraordinary manner of obtaining nitrogenous food for which they are famous—the capturing, killing and digesting of small animals.

The flora of our bog has one peculiar point of interest—it is one of the few plant-associations now to be found which is absolutely uninfluenced by ubiquitous man and his works. Over almost the whole of our islands the surface is under his control; even on the mountain-tops his sheep nibble the herbage and influence the flora, but here not even the sheep venture; the flora, the relative abundance of its constituent species, their dimensions and form, are purely natural. The fauna is natural likewise. A few Hares here find a secure retreat. The lonely Curlew makes its nest among the Ling, and the alert little Merlin selects for its breeding-haunt some spot where a mound or high tuft of moss furnishes it with a look-out tower. But the leading inhabitant of the great bogs, and the only one which conspicuously affects its flora, is the Black-headed Gull. This bird, selecting a remote piece of bog with numerous pools, forms breeding colonies containing sometimes thousands of nests. The effect on the bog flora is disastrous. Owing partly to the tramping, and probably more to the guano, plant after plant succumbs, until from the most thickly populated spots all are gone. In their place there springs up a vegetation less exclusive in its tastes and more tolerant of disturbance and of manuring. The seeds of these plants presumably come mostly adhering to the birds' feet, from the pastures and cultivated land where the Black-headed Gull mainly forages. Tall clumps of rushes spring up and grasses of several kinds, and with them Buttercups and Daisies, Chickweed and Groundsel, and many other weeds—a complete change of flora such as we seldom find except in connection with that arch-meddler, man.

We wander back to the edge of the bog, where the turf-cutters have, in the course of half a century, effected quite an appreciable nibbling into the vast brown vegetable mass. The section exposed by their operations is interesting. For a few feet from the surface the peat is loose and spongy and dries to a yellow colour, and in it we can detect plentiful remains of the plants which still flourish on its surface—stems of Heather, the far-creeping rhizomes of the Cotton-grass, and much *Sphagnum*. Below that the peat becomes more decayed, darker in colour and denser in texture, till at length it is a compact brown vegetable mud. In these lower layers are numerous great stumps of trees—Fir and Oak—with far-spreading roots. The lowest layer of black peat rests with startling contrast on a band of pure white marl, which in its turn is succeeded by a tough grey stony clay, which we recognise as the weathered surface-layer of the limestone drift, or Boulder clay, that is so thickly spread over the Central Plain of Ireland. Here, then, is a series of deposits which bridge over the great gap of time between the Ice Age and the present day—perhaps thirty thousand, perhaps sixty thousand years. Let us see what light the plant-remains which may be found in these deposits can throw on the successive floras that have occupied the surface during this vast period; thus we may link the present with the past, and learn something of the history of our existing vegetation, and of its ancestry.

During the Glacial period, ice covered a great portion of our country. The clays and gravels, full of ice-scratched blocks, often yield also marine shells, and these are largely of northern and arctic type, betokening very cold seas. Have any plants of this rigorous period survived, and what do they tell us? We may take in answer one of the interesting series of deposits discovered by the late Mr. Bennie, in the neighbourhood of Edinburgh. In a cutting at Corstorphine, lying on Boulder clay, the following beds occurred in ascending order*:—

1. Coarse grey sand, with stones. } The residue of the
2. Fine laminated clay. } Boulder clay.
3. Layers of fine clay, mud, or silt, with leaves and seeds in thin layers, or scattered.
4. Lake marl—a calcareous mud, crowded with the ordinary lake shells, and felted with stems of water plants.
5. Ochrey sand and gravel, six to seven feet thick, with little or nothing organic.

It is this bed 3 to which our attention must especially be directed. The plant-remains, worked out by Mr. Clement Reid, make the old flora which clothed Corstorphine Hill spread itself again before us. We see low Willows and Birches and Brambles clustering here and there, and while some of these still flourish in the district, others are now restricted to the mountain-tops, and others again have retreated to within the Arctic Circle. The Mountain Sorrel and Mountain Dryas, now alpine in their distribution, are here too, and many plants of moors and bogs, such as Sedges, Club-rushes, Bog-bean, Marsh Andromeda, and Crowberry. These no doubt grew around the marshy edges of the shallow pools, in which the plant-

* Bennie: "Arctic Plants of the Old Lake Deposits of Scotland." *Ann. Scott. Nat. Hist.*, January, 1894.

remains collected. But drier ground was near at hand, for with these, seeds of some of our most familiar wayside plants occur—the ubiquitous Chickweed, Buttercups and Violets, and that

> "Dear common flower, that grow'st beside the way,
> Fringing the dusty road with harmless gold,
> First pledge of blithesome May."

—the Dandelion. But the flora is distinctly northern, and the Arctic plants are indicative, says Mr. Bennie, of a climate 20° Fahrenheit colder than at present—a climate that would allow the Glacial Period to reign supreme.

At Hailes, not far away, two plant-beds were found.* The lower, resting directly on the Boulder clay, yielded a flora with arctic Willows, resembling that just described. Above this lay silts which yielded quite an extensive flora no longer arctic and stunted, but consisting of temperate plants, such as now occupy the country—Oak, Fir, Hazel, Birch, Alder, Black-thorn, and Bird-cherry; King-cups and Catchflies, Wood-sorrel, Meadow-sweet, Valerian, Red-rattle, Gipsywort, Bugle, Mercury, and Dock.

The white lake-marl, which underlies our bog, and which we have seen to overlie the glacial plant-bed at Corstorphine, is a deposit widely spread in our islands, and frequently met with. The passing away of the ice left the country strewn with ridges and mounds of clay and gravel, which, interfering with the old drainage, conduced to form numerous lakes and pools. And as the country became again clothed with trees and herbaceous vegetation, the waters also were colonized by an abundant flora, which advanced from the south as the ice retreated further and further northward. Among the plants which flourished were quantities of *Characeæ* or Stoneworts, many of which have their stems habitually encrusted with lime, whenever a sufficiency of lime is dissolved in the water. Various plant-eating water-snails swarmed in these pools, and also water-fleas or *Entomostraca*, which have calcareous tests. As generation after generation of these plants and animals came and went, their limy crusts or shells fell to the bottom of the pools, and by degrees formed these white beds of marl. The process may still be seen in actual operation. Mr. Skertchly found† that the evaporation of the water in the ditches of Burwell Fen during the exceptional drought of 1874 left a white deposit of *Chara* remains from two to four inches in thickness. If a sample of this white marl be examined carefully, the roots and seeds of *Chara* may almost always be found, and there can be little doubt that plants of this genus largely contributed to its formation. The conditions under which a deposit of the kind would form are such as still obtain around our bog. First, the water must be charged with carbonate of lime—in the great limestone plain of Ireland it is difficult to find water that is not! The water must be clear, for Charas do not favour muddy pools; and the pools must be of moderate depth. To judge from the wide range of these marls, such conditions must have been frequently fulfilled in the post-Glacial lakes. The marls are poor in plant-remains in general. The still clear waters in which they were formed would not receive seeds and fragments of the shore vegetation in the ordinary course, as would a turbid pool through which a stream ran; and the material itself is far less fitted to preserve plant-remains than beds of fine silt. Nevertheless, in a sample of the marl taken not very far from the spot where we now in fancy stand, Mr. Clement Reid found‡ seeds of Water-buttercup, Milfoil, Shore-weed, Club-rushes, Sedges, and two Pond-weeds, all being plants, it will be noticed, that would grow in the pool or on its edges. Water-snails, which delight in clear limy waters, were abundant in these old lakes, and their shells sometimes form a considerable portion of the deposits. Several species of *Limnæa*, *Succinea*, and *Valvata* are often present in numbers, and also representatives of the genera *Sphærium*, *Planorbis*, *Physa*, *Bythinia*, *Pisidium*, &c., all being species which are still abundant in our ponds; so that the fossils, both vegetable and animal, point to a climate hardly distinguishable from that which now obtains, and to a flora and fauna closely resembling the present. One characteristic fossil of these Irish marls has, however, yet to be mentioned. It is in these deposits rather than in the peat which overlies them that the remains of the Great Irish Deer, *Cervus giganteus*, commonly known as the Irish Elk, occur, often in surprising quantity. This splendid animal stood as much as 21 hands, or 7 feet high, and its antlers measured 10 feet or more across; it attained an abundance in Ireland unequalled elsewhere in its range, which stretches chiefly over northern Europe (though reaching as far south as Italy) into Siberia. In the old bed of one small lake among the hills of County Dublin, over one hundred heads have been obtained. Appearing in these countries after the Great Ice Age, this noble animal must have been roaming the plains in thousands at the time when the slow accumulation of limy sediment was forming these white marls; ere the forest period which succeeded had arrived, the Great Deer had vanished from the face of our planet.

Thus have we briefly sketched, by means of the plant-remains embedded in contemporary deposits, the history of the flora of our country, from the repeopling of the land on the departure of the ice to the time when many of the lakes which formed on the surface of the Boulder clay had silted up. Immediately overlying the white marl in the turf cuttings of our bog are the lowest layers of the peat which rises full thirty feet in thickness. The history of the bogs—their birth, life, and death—must form the theme of a subsequent chapter.

* Clement Reid: "Origin of the British Flora," p. 72-74. 1899.

† *Mem. Geol. Survey England and Wales: Geology of parts of Cambridgeshire and of Suffolk*, pp. 98, 99. 1891.

‡ "On the Origin of Migaceros-marl." *Irish Naturalist*, IV., pp. 131, 132. 1895.

COLLECTING, PRESERVING, AND MOUNTING ALGÆ.

By Henry J. Foster.

Many microscopists would be glad to be acquainted with the best methods for collecting, preserving, and mounting as microscopical specimens, the beautiful varieties of marine and fresh-water Algæ, and the information that it is here proposed to give will, it is hoped, enable this to be done.

It will be found desirable to combine both the marine and fresh-water varieties in collections, for in their botanical arrangement according to structure and modes of growth, the steps in the scale of nature towards higher forms are independent of the accident of habitat. The exquisite structure, differing in every species, causes these subjects to be of especial interest to the microscopist, and that interest is immensely increased when he has collected, prepared, and mounted the specimens for himself. Although it is eminently desirable that classification and nomenclature should be attempted, it is of course not an essential; but there is little doubt that preliminary observation will ultimately lead to fuller investigation, and perhaps to real study.

Marine Algæ.—If the collection of these specimens is to be an object in a visit to the seaside, it will be well to choose for preference a rocky and perhaps somewhat bleak coast, where there is an abundance of rock pools.

The low sandy shore or flat muddy estuary, though yielding their peculiar species, are not by comparison to be considered.

Mr. George Murray in his introduction to the Study of Seaweeds gives the following information regarding the three colours of seaweeds:—"As a general rule the inshore seaweeds near high-water mark are green in colour like land vegetation, and lower down between tide-marks there is a belt of olive forms sheltering red plants beneath them. Where rocks overhang the bottom and in small pools these red forms also occur at this level. At extreme low-water mark and beyond it are found the brown tangles sheltering red forms again, while at the lowest depths of plant life in the sea the red forms occur without shelter."

The collector should provide himself with some small tin boxes, such as are used by botanists, and these should contain little oiled silk bags in which to place the specimens; or an ordinary water-proof sponge bag hung on the arm is a good receptacle. A strong short chisel, firmly fixed at the end of a stout stick of alpenstock pattern, and having at the other end a small net, is also necessary, the former to dislodge pieces of weed from shells or rocks otherwise beyond reach, the latter to catch floating specimens. The stick will also be found useful as a support when on the rocks, for it is here when the tide is at its farthest that he will have to search for his treasures.

They will be found in the little pools about the rocks, some growing on pebbles, others on shells, while some will spring from the rock itself. After a storm is a particularly propitious time for search to be made along the shore, for tufts will frequently be torn from inaccessible regions, while at other times a variety of specimens will be found thrown up by the waves and stranded on the beach. The waste of a fisherman's haul should also be examined.

Specimens thus secured may be preserved in sea water without deterioration, and in particular Delesseria alata, Polysiphonia, Callithamnion, and Bryopsis ulva thrive well in aquaria. The collected material should be placed in transparent receptacles, such as glass jars, so that they may be readily examined.

Marine Algæ make particularly good dried specimens, and the method to be adopted for preserving them in this manner is as follows:—They should be thoroughly washed, first in salt water and finally in fresh water. The specimen should then be placed in a shallow dish, and a sheet of drawing paper gently placed beneath it as it floats in the water; the paper may then be gradually drawn up and the specimen thus lifted in its spread out condition. The specimens so arranged should then be carefully covered with drying paper, and botanical pressure boards or a board with a considerable weight upon it should be used, the papers being changed frequently until the specimens are quite dry.

It has to be remembered that the dried specimens rarely retain the beautiful colours of the living plant. In many cases the chlorophyll granules are embedded in the pigments of various colours, and are sometimes almost indiscernible.

On the death of the plant these colouring matters frequently undergo a change, and much of the beauty of the specimen is thereby lost.

The process of mounting marine Algæ for the microscope is quite simple, and with care and practice the work can be done with great facility. The *modus operandi* is as follows:—The weed should be well washed in the same manner as for dry mounting, and the portion which shows the most interesting structure—fructification, etc., if possible—should then be removed with a sharp pair of scissors and transferred with the forceps to a 3 by 1" slip. It is then carefully drained of superfluous water by a cloth placed close to it to absorb the moisture. It must not, however, be allowed to get perfectly dry.

The best medium for mounting is Deane's gelatine, which is reduced to a fluid condition by placing the bottle containing it in a bath of hot water. The slips should now be very gently warmed, and a small quantity of the medium transferred, by means of a warm glass rod, from the bottle to the slip. The amount of medium should be just sufficient in quantity for a ¾" circle to cover comfortably.

The cover-glass having been warmed in a spirit lamp flame on the side which is to be away from the specimen, is gradually tilted down on the specimen and the slide set aside to cool, the exuded gelatine being removed when hard by means of a knife and a piece of soft sponge dipped in warm water, and used as rapidly as possible. It may subsequently be finished with any of the varnish cements.

For travelling purposes the majority of the specimens may be safely carried in wide-mouthed bottles with well-fitting corks, and many species will keep thus for months or even years, but some delicate specimens, such as Callithamnion corymbosum, Sphondylothamnion multifidium, and Mesogloea, are best kept in glycerine until required for mounting, the glycerine being washed off beforehand.

The corallines are red sea-weeds whose tissues are hardened by chloride of lime. Before mounting they must be cleared by washing in a weak solution of hydrochloric acid, or, better still, by using Perenyi's decalcifying fluid.

Fresh-water Algæ. — The majority of specimens when collected require to be placed and carried in water, necessitating that the collector shall take with him some well-corked wide-mouthed bottles.

One of the most generally useful arrangements for gathering specimens is one of the collecting sticks sold by opticians, which is provided with net, bottle, cutting hook, drags, etc. These various fittings enable all kinds to be taken—the free-swimming Volvox, the floating Spirogyra, and the Desmids and Diatoms, which may be found in the mud at the bottom.

It will often be found convenient to concentrate gatherings, which may be done by stretching a piece of fine muslin across a bottle, superfluous water being drained away and the specimens retained, and all placed in one instead of several bottles.

To preserve fresh-water Algæ, it will be found advantageous to shield them from direct light by tying a stiff piece of green paper round the vessel in which they are contained.

In mounting these specimens for microscopical examination, the same processes may generally be adopted as for marine Algæ, excepting that of course the salt-water washing is omitted, but the delicate structure of many of the species necessitates their being mounted in a cell. The medium that has proved most generally satisfactory is Deane's gelatine, thinned with camphor water, or with distilled water containing a trace of pure carbolic acid. The gelatine keeps the medium from evaporation, and is easier to use than an ordinary fluid. Some species, such as Enteromorpha, may be mounted in the Deane's medium without dilution. Spirogyra and Volvox are better mounted with Deane's gelatine 50 per cent., and thinning material for the other half. Spirogyra may also be mounted in dilute alcohol, and this shows up the nucleus, although the colour suffers.

Specimens mounted in fluid or semi-fluid media should be sealed up immediately in order to prevent evaporation. This is best done with a ring of Hollis's glue, and care should be taken to finish with a sufficiency of varnish to prevent all chance of evaporation at later periods.

Conducted by M. I. Cross.

Pond-life Collecting in September.—In normal years many of the dried-up ponds begin to fill up again in September, and become then most prolific in Infusorian and Rotiferous life, because the disturbing Crustaceans, Cyclops and Cladocera, have been to a large extent eliminated. But also in larger ponds and lakes, which do not dry up, the Crustaceans decrease in numbers and give the Rotifera and Infusoria a fresh chance of increase. The following free-swimming forms may often be collected in immense numbers by means of the Quekett's collecting net and bottle: *Asplanchna priodonta, intermedia* and *brightwelli; Triarthra longiseta; Polyarthra platyptera; Synchaeta pectinata, tremula* and *oblonga; Anuraea aculeata* and *cochlearis; Brachionus angularis; Pedalion mirum; Conochilus unicornis;* and the much rarer *Floscularia pelagica.* Of the fixed forms *Limnias ceratophylli* and *annulatus, Cephalosiphon limnias, Lacinularia socialis, Melicerta ringens* and *conifera* should be looked for on submerged water plants, such as Anacharis, Ceratophyllum, Nitella, and on the rootlets of Duckweed. Polyzoa such as Plumatella, Lophopus, Cristatella, should be found in abundance in disused canals and backwaters of rivers and the larger lakes, from which they should be dredged with a loaded hook and line.

It may be taken as a general rule that all the more interesting forms of Pond-life become more abundant in September, provided only the weather is not too hot, but tempered by repeated showers to fill the dried-up ponds with a fresh supply of rain water.

Microtomes.—The selection of a microtome is largely dependent on the description and quality of the work that it is proposed to do. The majority of amateurs find their aims satisfied with the ordinary well microtomes which are made in numerous forms: and for those who do occasional work, and that not of the finest kind, in which sections of extreme tenuity would be essential, these are undoubtedly good and satisfactory.

Further, ability to cut sections of a certain kind with them is easily attained; but to do the best that is possible with them requires as much practice and experience as is necessary for the acquirement of facility in any other line.

There is, however, a limit to the capabilities of these microtomes even in the hands of the skilful and trained manipulator, and it is beyond this that resort has to be made to one of the more complex forms of microtomes, of which so little is known outside laboratories. It is proposed therefore, in a brief way, to mention some of the leading forms of microtomes, and their special features.

Of English make there are but two microtomes that have a right to be reckoned as of the first rank; one is the well-known Cambridge Rocking Microtome, made by the Scientific Instrument Co., of Cambridge, and the other is the "Delepine," made by Messrs. R. & J. Beck. The former is designed especially for the cutting of tissues of small size embedded in paraffin wax, and for that particular purpose it has probably no superiors, and when once its peculiarities and possibilities have been thoroughly grasped, it is capable of work of the highest class.

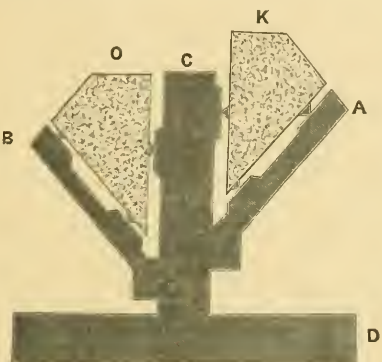
The "Delepine" Microtome, which has been made by Messrs. Beck to the suggestions and designs of Professor Delepine, is intended specially for the cutting of frozen tissues; it is of substantial build and excellent design.

Beyond these, it is necessary to go to the Continent for our wants to be supplied, and all of the makers, which are very limited in number, make instruments which have special points of value for different workers. Some of them are familiar to the ordinary microscopist through their inclusion in English microscopic catalogues, but there are others which are rarely heard of, and are deserving of consideration.

One of the cheapest microtomes that can be considered of a practical description is that made by Schanze, of Leipzig. The jaws will hold an object $1\frac{1}{8}$ inches by $\frac{3}{4}$ inch, and the object can be orientated and fixed in any position. The knife-holder guides consist of three raised rails 7 inches long. Provision is made for the measurement of the thickness of the section by means of the micrometer screw, which is of good construction. The price of this complete is 35s.

Next to this is an exceedingly efficient instrument by Jung, of Heidelberg (his catalogue No. 119), which is provided with an automatic raising arrangement to the object holder of very ingenious description, the knife being brought into action by a swinging movement. It can be used both for embedding and freezing. The price of this in case complete is 50s.

The same maker is responsible for the Rivet Model Microtome, which is considered one of the most generally useful and best machines by a large number of workers. In this, the knife moves in a horizontal plane, and the object in an inclined plane. The accompanying figure gives a diagrammatical view in section of this microtome.



D is the base of the microtome.

C is the central support.

The V guides formed by AC and BC have projecting friction surfaces; while the two blocks O and K, the former the object carrier, the latter for the knife, have fine ivory points where they make contact with the guides.

The V fitting BC is inclined one in twenty, and, obviously, as the block O is caused to move along the groove, the object is raised. A suitable vernier is fitted, which gives exceedingly fine readings for the travelling imparted, which may be effected either by micrometer-screw or hand.

(To be continued.)

Measuring Apertures of Objectives.—It is generally supposed that the only suitable means obtainable for measuring the apertures of objectives is the apertometer made by Zeiss. Truly, this does work efficiently, yet even with it, marked discrepancies frequently occur between the results obtained by independent observers, and it seems to be peculiarly difficult to secure uniformity, especially with dry objectives having large back lenses and oil immersion lenses. Accuracy with this, as with many other instruments, greatly depends on experience and practice.

The apertometer itself would be so very rarely used by the ordinary worker that it is not considered a necessary adjunct, added to which its expense is in itself an obstacle. This is pointed out in an extremely useful paper by Mr. H. F. Angus, which appears in the *Journal* of the Quekett Microscopical Club for April, 1902; and he further proceeds to suggest ways and means for ascertaining the apertures of dry objectives with very simple means.

The most practical is probably the protractor apertometer, which consists essentially of an ordinary semi-circular protractor mounted vertically on a base with its diametrical edge towards the objective, and having attached to its circumference two movable pointed indicators. The following is the method of using it:

A silvered cover-glass is attached to a piece of glass the thickness of an ordinary slip, the centre of the silver being removed for an aperture of about one mm. The objective is focussed on the centre of the disc, and if the eyepiece then be removed, the whole of that part of the protractor which the objective takes in will be found to be visible at the back of the objective, and if the pointers be set to the edges of the field the reading can be taken. As, however, the image seen will be small, it will be necessary to enlarge it, and this may be done with a supplementary lens, placed at the lower end of the draw-tube, replacing the eyepiece and focussing the image by means of the draw-tube, the moving parts of the microscope being held the while to prevent the objective from being shifted out of focus on the disc.

The lens at the lower end of the draw-tube must be a low power one, such, for instance, as the posterior half of a 2-inch objective. The angular reading thus obtained can be converted into numerical aperture by reference to the tables of comparative angles and N.A., which are to be found in nearly all text books, or by using a table of sines.

It should be mentioned that this system is obviously applicable only to dry objectives, but a ready way of approximately ascertaining the aperture of an oil immersion objective is by placing a piece of tissue paper over the front of the objective, holding it towards the light, and looking through the back lens. If the aperture of the objective exceeds 1·0 N.A., there will be a central annulus of light surrounded by a dark zone; and the greater the width of the dark zone, the more does the numerical aperture exceed 1·0.

The article, in addition, gives some interesting and valuable information founded on a rational basis regarding the proportion of diameter of stop to be used with the condenser to produce background illumination, with a given objective.

NOTES AND QUERIES.

Genl. Warrand.—The gentleman who acts as consultant *re* Rotifers replies as follows:—"I am sorry to say I cannot give you much information about the feeding of Rotifers and other forms of pond life, as I have never been very successful myself. I have kept Melicerta for about three months, and Stephanoceros for two, but that is about all. I keep my bottles filled with water from a rain tub in my garden, and occasionally put in a drop or two of 'soup' made by pulverizing some *Anacharis* in water. I do not think an infusion of hay is the slightest use for the purpose."

A. J. R.—(1) The best condenser for your purpose will be either Baker's achromatic small-sized condenser with a back lens of 22 mm. diameter, or Watson's "Universal." The former is probably the more suitable for your work, because it is more useful for low-power objectives with the top lens removed than the latter. (2) A ½-inch objective by any of the leading makers will give you satisfaction. (3) There are several other processes in the preparation of an insect as a micro object. You could probably gain the information you require from any of the books on mounting objects. (4) The 1-inch objective and "B" eyepiece is the most generally useful for examining crystals with the polariscope.

C. M.—I have submitted your drawing to consultants, and, so far as can be ascertained, it is likely to be that of the Common Phantom Larva, *Corethra plumicornis*. I am much obliged for your kind offer, but the delay that necessarily occurs in replying to queries will probably preclude your gathering them.

F. C. P.—Synapta is a genus of vermiform Echinodermata of the order Apoda. Anchors and plates serve to aid in locomotion, adhesion, and, it is supposed, for impaling food. The species with these plates, &c., are usually of foreign origin.

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.

SWIFT'S COMET (1895 II.).—This faint comet was discovered in Pisces on 1895, August 20, and observed for several months. Elliptical elements were computed for it by Berberick (period 7·06 years), Boss (period 7·22 years), Schulhof (period 7·19 years), and others. Schulhof's period is liable to an uncertainty of only 15 days The return of the comet is shortly expected, and the following ephemeris has been computed by F. E. Seagrave, though the conditions are not favourable:

		R.A.				Dec.			Distance in Millions of Miles.
		H.	M.	S.		°	′	″	
September 2	...	16	15	55	−	17	51	38	115
„ 10	...	16	31	10	−	18	46	21	116
„ 17	...	16	47	55	−	19	34	56	117
„ 24	...	17	6	1	−	20	18	28	117
October 1	...	17	25	21	−	20	55	10	118
„ 8	...	17	45	51	−	21	23	23	118

Thus the comet pursues an easterly course from Scorpio to Sagittarius.

HERVE FAYE.—The death of this eminent French astronomer occurred on July 4th, at the age of 88 years. Born in 1814, Faye's early inclinations led him to the pursuit of astronomy, and on the initiative of Arago he became an assistant at the Paris Observatory. On 1843, November 22, he discovered a small comet with a fan-shaped tail in the northern region of Orion, and it remained visible until 1844, April 10. Dr. Goldschmidt, of Göttingen, and others, computed the orbit, and found it an ellipse of short period (7⅓ years). M. Le Verrier predicted that the comet would return to perihelion on 1851, April 3, and the prediction was accurately verified by the event. M. Faye was better known as an astronomical writer than as a telescopic observer, though his name has long been familiar to us by its association with one of the most notable and best known of our short period comets. It last returned to perihelion in March, 1896, and its next apparition will occur in the autumn of 1903.

BRILLIANT FIREBALL.—One of those vivid meteoric apparitions which now and then startle observers who are little prepared for such spectacles was presented on Sunday night, July 13th, at 10h. 30m. p.m. The firmament seems to have been clear generally, and the descent of the fireball was witnessed by a great number of persons. The position of the object was over the Straits of Dover, so it was seen in the S.E. sky, the direction of course varying somewhat according to the station. Numerous descriptions of the phenomenon have been published in the newspapers, but 19 out of every 20 of these afford no useful material for computing the meteor's real path in the air. Most of the spectators content themselves with alluding to its sudden and dazzling lustre, to the serpentine trail which lingered for many seconds after the flash, and to the general direction in which it appeared, but give no exact information as to the path traversed. Fortunately, however, a few of those who saw the object were astronomical observers, who recorded its chief features, and amongst these were Mr. W. E. Besley, of Clapham, S.W., Mr. E. Holmes, Hornsey Rise, N., Mr. T. Crumplen, Hungerford Road, N., Mr. E. Rabone, Highgate, N., Mr. E. W. Barlow, Surbiton, Surrey, Mr. W. H. Maw, Outwood, Surrey, Lieut.-Col. Tupman, of Harrow, and the writer at Bristol. It is not essential to give the descriptions in detail, nor can space be afforded for the purpose, but it may be briefly stated that as seen from London the meteor was projected on the sky in the immediate region of the stars forming the constellation Delphinus. Mr. Besley, at Clapham, S.W., recorded the path as from 311° + 21° to 310½° + 16½°, while Mr. Rabone, at Highgate, N., put it as 312½° + 14° to 312½° + 11°. At Bristol the writer registered it as 329½° + 12° to 332° + 8°. The meteor was seen at such distant places as Liverpool, Shrewsbury, Aberdare, and Moreton Hampstead, Devon. Comparing the best observations the radiant point is indicated at 315° + 31° near ζ Cygni, and the meteor fell from 89 to 51 miles from E. of Boulogne, France, to E. of Dungeness, coast of Kent. Path 51 miles, and velocity about 26 miles per second. Had the meteor been able to withstand disruption it would have fallen upon the earth near Uckfield, Sussex. Mr. Besley has also determined the real path, and finds that the meteor descended from a height of 86½ to 52½ miles over 11 miles W. of St. Omer, France, to 11 miles W. of Cape Gris Nez. Length 45 miles, velocity 22½ miles per second. Radiant 316° + 30°. The fireball had rather a short path, and it seems to have been isolated, for no other meteors belonging to the same radiant were seen by the writer at Bristol, either on July 13th, or on the clear nights preceding and following that date.

FIREBALL OF JULY 15TH, 9H. 32M.—Though less brilliant than the fireball of July 13th, this object was conspicuous from its long flight and slow motion. It divided into two near the end of its course. Directed from a westerly radiant in Libra, at about 236° − 12°, it passed over the counties of Essex and Suffolk, descending from 60 to 38 miles in height. Its luminous course was about 51 miles long and velocity 17 miles per second. This real path was computed by Prof. A. S. Herschel, who fortunately observed the meteor from near Windsor, and recorded its flight as from 303° + 33½° to 313° + 39½°, and its duration as three seconds.

THE FACE OF THE SKY FOR SEPTEMBER

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

THE SUN.—On the 1st the sun rises at 5.12 A.M., and sets at 6.47 P.M. On the 30th he rises at 5.59 A.M., and sets at 5.41 P.M.

The equinox occurs on the 23rd, when the sun enters the *sign* of Libra, and Autumn commences.

The first and second days of the month are good days for employing the sun to get a meridian line or other similar purposes, for then the equation of time is negligible, the sun being with the clock.

The Zodiacal Light may be looked for in the west after sunset.

Sunspots are very scarce.

THE MOON:—

		Phases.	h. m.
Sept. 2	●	New Moon	5 19 A.M.
„ 9	☽	First Quarter	10 15 P.M.
„ 17	○	Full Moon	6 23 P.M.
„ 24	☾	Last Quarter	4 32 P.M.

The Moon is in apogee on the 10th and in perigee on the 23rd.

Occultations.—On the 22nd of the month the double star δ Tauri suffers occultation, whilst on the 13th there is a near approach to β Capricorni. The particulars are as follows:—

Date.	Star Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
			h. m.	°	°		°	°	d. h.
Sep. 13	β Capricorni	3·4	6 48 P.M.	347	7	—	—	—	11 13
„ 17	21 Piscium	6·1	11 31 P.M.	359	5	12 3 A.M.	309	309	15 18
„ 22	δ^1 Tauri	4·0	9 2 P.M.	18	55	9 25 P.M.	322	0	20 16
„ 22	δ^2 Tauri	4·7	9 14 P.M.	59	96	10 2 P.M.	281	321	20 16
„ 23	115 Tauri	5·4	10 34 P.M.	130	168	11 12 P.M.	219	259	21 17
„ 26	68 Geminorum	5·0	1 40 A.M.	92	132	2 40 A.M.	278	318	23 20

THE PLANETS.—Mercury is in Virgo, but sets very shortly after the sun.

Venus is in Leo, and is still a very bright object in the early dawn. She rises about two hours in advance of the sun. On the 11th and 12th she is near the star Regulus, whilst on the morning of the 30th she is near the moon.

Mars is a morning star in Cancer, rising about 1 A.M. The apparent diameter is increasing, being now about 4″·5, whilst 0·95 of his disc is illuminated.

Jupiter is a most brilliant object, and on looking southwards, not very high up, his magnificence immediately catches the eye. The planet is on the meridian about 9 P.M. at the middle of the month, and he sets shortly after 1 A.M.; his apparent diameter is now about 43″. On the evening of the 14th he is a little to the east of the moon.

Observing at 9.30 P.M. on the 6th, 7th, 12th, 19th, three satellites only will be visible, the other being in transit, whilst at the same time on the 4th, 15th, 16th, 20th, 24th and 27th one satellite will be in eclipse. On the 23rd, at 9.30 P.M., satellites I. and III. only will be visible, for satellite IV. is in transit and satellite II. is eclipsed.

Saturn is to the westward of Jupiter, and souths about 8 P.M. He forms a very conspicuous object in the sky, not very high up, and shines with a slight reddish tinge. The planet is near the moon on the 12th, and at the stationary point on the 26th. The ring is now widely open, and we are looking down on the northern surface of it. The following are some of the elements for the ring for September 17th:—

Outer major axis, 40″·57.
Outer minor axis, 16″·15.
Elevation of the earth above ring plane, 23° 28′.

Uranus is in Ophiuchus, but sets before midnight. He is therefore not well placed for observation on account of his great southern declination. The planet is in quadrature with the sun on the 11th.

Neptune is visible rather late on in the evening. He is in Gemini, near the stars μ and η Geminorum, and rises about 10.30 P.M. His diameter is about 2″, and he shines with only the brightness of an 8th magnitude star.

THE STARS.—At the beginning of the month, at 9 P.M., the following constellations are to be observed:—

ZENITH .	Lyra, Cygnus.
SOUTH .	Aquila, Delphinus, Aquarius, Capricornus, Sagittarius; Serpentis, Ophiuchus, and Scorpio, to the S.W.
EAST .	Andromeda, Pegasus, Pisces, and Aries; Pleiades on horizon.
WEST .	Hercules, Corona, Boötes.
NORTH .	Ursa Major, Ursa Minor; N.E., Cassiopeia and Perseus; Auriga (*Capella*) on horizon.

Minima of Algol will occur on the 3rd at 8.0 P.M., 21st at 12.52 A.M., and the 23rd at 9.41 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. 10.

Key-move.—1. Kt to Q4.

If 1. . . . P to B3,	2. Kt to K6, etc.
1. . . . P to K4,	2. Kt to B6ch, etc.
1. . . . K to B4,	2. Kt × Pch, etc.
1. . . . K to K5,	2. Q to K6ch, etc.
1. . . . Anything else,	2. Q to K6ch, etc.

No. 11.

The Composer's intention was 1. Q to QB8, but W. Jay has discovered a second solution beginning 1. Q to K7ch, followed by B to B8 or Q to Q6 accordingly. It is a pity that the "much labour" was all in vain.

No. 12.

Key-move.—1. Kt to B6.

If 1. . . . K × Kt,	2. Q to Q3, etc.
1. . . . B × P.	2. Q to R8, etc.
1. . . . B × Kt,	2. Q to QB3, etc.
1. . . . B to Kt2,	2. Q to QKt3ch, etc.

SOLUTIONS received from W. Nash, 4, 4, 4; Alpha, 4, 0, 4; W. Jay, 4, 6, 4; G. Woodcock, 4, 0, 4; G. W. Middleton, 4, 4, 4; C. Johnston, 4, 4, 0; "Looker-on," 4, 4, 4; J. W. Dawson, 4, 4, 4. "Tamen's" solutions were posted too late to score.

Alpha.—In No. 2 you seem to have overlooked the reply 1. . . . P to B7 (dis. ch.), in answer to 1. Kt to K3.

G. Woodcock.—In No. 2, 1. K to Q8 seems to be answered by 1. . . . B × Kt, 2. Q to Q6ch, K to B4 (!).

J. C. Candy.—Thanks for the problems. If found correct they will appear during the winter.

Note on Problem No. 9.—My decision last month that the duals in this problem were different duals, because they resulted in different mates, was, perhaps, too hasty. As a matter of fact, the stipulation as to the Chess-Editor being the sole judge as to repeated duals was intended rather to apply to the case of a dual in one variation, and the same dual *plus* a triple in another. But the argument in the present case that the dual continuations are the same (the solver having nothing to do with *third* moves) seems unanswerable. I must express, therefore, my regrets to W. Jay, J. W. Dawson, and H. Myers, for having to deduct the extra point scored to them last month.

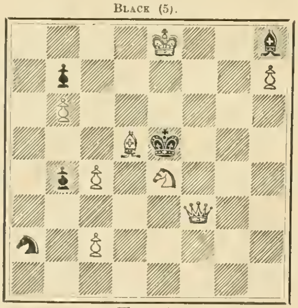
With regard to the judging of the problems, I expect that it will be found necessary to invite the co-operation of those solvers who fail in one problem only, with perhaps the stipulation, in fairness to the composer, that the unsolved problem in each case shall be placed high on the list of the judge who was defeated by it.

PROBLEMS.

No. 13.

"Leonard."

BLACK (5).



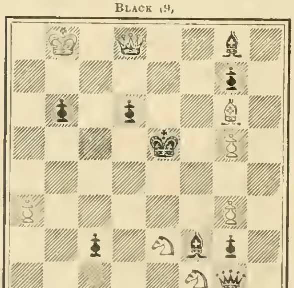
WHITE (8).

White mates in three moves.

No. 14.

"Knowledge rather than choice gold."

BLACK (9).



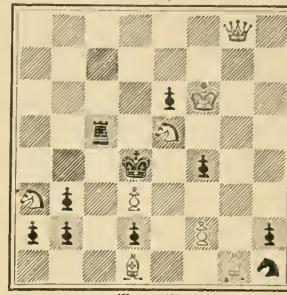
WHITE (8)

White mates in three moves.

No. 15.

"Variety charms."

BLACK (10).



WHITE (8).

White mates in three moves.

CHESS INTELLIGENCE.

The prize-winners in the International Tournament at Hanover, concluded on August 11th, are :—

1.	D. Janowski...	$13\frac{1}{2}$
2.	H. N. Pillsbury	12
3.	H. E. Atkins	$11\frac{1}{2}$
4.	J. Mieses	11
5.	J. N. Napier } J. Wolf }	10
7.	M. Tchigorin	9
8.	Dr. Olland	$8\frac{1}{2}$

The other competitors were F. J. Marshall, J. Mason, I. Gunsberg, C. V Bardeleben, Cohn, Suchting, Gottschall, Lewin, Popiel, and Swiderski. It is only fitting that Janowski and Pillsbury should fill the first two places, but Mr. Atkins' position, only half a point behind Pillsbury, in this his first appearance in a master-tournament, is a most encouraging sign for English chess. M. Tchigorin recovered somewhat after a very bad start, but Messrs. Marshall, Gunsberg, Mason, and V. Bardeleben, played much below their form. The entry was not nearly so strong as had been expected, and a master-tournament without Lasker, Maroczy, Tarrasch, Schlechter, Blackburne, and Teichmann, cannot by any means be considered representative. Mr. R. Loman obtained 6th prize in the minor tournament. He recently lost a match with Mr. C. H. Sherrard by 4 games to 1, with one draw.

It is probable that the number of players in the North *v.* South Correspondence Match next autumn will be increased to 150 aside. The South have already found more than this number of would-be competitors, and it is probable that the Northerners will prove equally keen.

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

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CONTENTS.

THE ORIGIN OF SPECIES IN SOCIOLOGY.

By J. COLLIER.

SOCIOLOGICAL species consist of family types, forms of government, industrial and ecclesiastical organizations, games and sports, manners and fashions, languages, sentiments and beliefs, philosophies and sciences, literatures and arts. They possess all the characters of vegetal and animal species, and have the same kind of reality. They transmit those characters from generation to generation. They yet develop in definite directions, from a less to a greater degree of perfection. They have a local habitat, even when it belts the world. They battle with one another for existence, and the fittest survive. They have likewise peaceful intercourse with one another, and exhibit all the phenomena of cross-fertilisation. What concerns us now, they spring up as new species of animals and plants spring up. The law of constant variation in all species and in every organ is as operative in sociology as in biology. Some slight accidental or involuntary modification of an existing usage hardens into a practice, from individual and private becomes public and general, and in course of time assumes a shape wholly unlike its first form, and perhaps contrary to the intentions of its originator. We shall give a few examples from various branches of sociology:—

1.—The origin of the feudal system, as it has been infelicitously termed, was the crux of constitutional history throughout last century. Reeves, the historian of English law, asserts that two statutes enacted by William the Conqueror definitely established it all over England. That is an example of the doctrine of special creations in history. No accredited writer would now express himself so loosely, but it is a specimen of hundreds of opinions that still prevail about the origin of social institutions. When the theory of special creations has been dislodged, its place is taken by the hypothesis of social deluges and cataclysms. The eminent German or Germanising writers who have lately reconstructed the constitutional history of the Middle Ages—Waitz, Roth, von Maurer and Sohm, Freeman and Stubbs—explain the origin of sociological species as Cuvier explained the origin of animal species. Feudalism was the outcome of what a scholar like Brachet, with the uniform development of the French language before his eyes, does not hesitate to call "the inundations of the fifth century." The invading Germans took possession of Gaul, England, Spain, and northern Italy as conquered countries. In each they found thousands of farmers in occupation of the soil. Exercising the right of eminent domain claimed by all conquerors, they confiscated the entire fee simple, and converted the occupiers into serfs. Certain usages, the benefice and companionship, were transported bodily from Germany, and formed the pillars of the new social system. A whole set of national institutions was submerged, and a complete new set was founded on their ruins. To the anthropologist and the antiquarian this revolutionary theorising has long been a stumbling-block, and to the sociologist foolishness. The new school maintains, on the contrary, that there were no real invasions. Small commandoes (sometimes coalescing) filtered across the frontiers and slowly blended with the native populations. There were neither victors nor vanquished. The Germans came on the invitation of the Roman rulers, and were gradually Romanised. They scarcely changed the ethnical composition of the various peoples, but at the most reinforced the blonde long-headed element. The political transmutation was slow and imperceptible. No new *régime* was founded. There were no radical changes in the status of persons or property. There was no expropriation. Nevertheless, between the fifth and the ninth centuries, a slow transformation of manners, usages, and ideas took place throughout western Europe. Founded by no public laws or degrees, but built up stone by stone as the result of hundreds or thousands of isolated private acts, turning insensibly into habits which were at length firmly rooted, that astonishing feudal structure was reared which it took the energies of a whole people to overthrow in 1789.

We can here follow this very complex evolution only along a single line. What was the origin of one of the most characteristic features of feudalism—medieval serfage? No article of the Digest, no law of the Codes, no account by any historian records its birth. Serfage was formed slowly, obscurely, and without being observed. It began as a slight variation of existing usages; its first rudiment was a tiny germ deposited in the bosom of ancient slavery? The late Fustel de Coulanges detected its rise in a brief statement made by an ancient Roman writer on agriculture. The voluminous Varro alleges that the master who was satisfied with a slave sometimes granted him a piece of land, together with a flock of sheep or a herd of cattle. A Servian story of Sacher-Masoch's suggests that such a donation may sometimes have been made as the dowry of a discarded mistress. Varro adds (and the addition is important): "bestow on him this boon; he will be the more firmly bound to your domain." This short reference contains in summary the chief rules of medieval serfage. The slave was allowed to live apart, to till the field that had been assigned him, to tend his flock or herd. He was still obliged to labour on his master's estate some days in every week; and this provision differences Roman serfage from Greek or German, but identifies it with medieval serfage, and seems to prove the affiliation. The rest of the time the slave, thus segregated from the troop, was his own master, he was to that extent a serf, no longer a slave, his plot was held by a tenure.

The serf, whose humble beginnings we thus witness, soon acquires a more defined status. The jurists of the second and third centuries mention the slave who pays a due to the proprietor, like a farmer. Ulpian even names him a quasi-farmer. The jurist Paul signalises the slave who tills land at his own risk, and pays a rent fixed in advance. Two other jurists speak of a "lease of land" made to a slave.

The status of the individual was not changed. He was still legally a slave. He had no rights as against the master; the plot could at any time be resumed. At his death the owner did resume it. The slave's children could not inherit it. Nevertheless, the master found it to his advantage to leave the slave in occupation of it; he worked harder on land that was almost his own, and it yielded a larger return. When the slave died, it might be also to the master's advantage to leave his family in possession of it. The servile tenure would thus become permanent, and almost hereditary.

At the end of the third century a new step was taken. A fresh roll of all throughout the empire who were liable to pay the land-tax was compiled. Finding many slaves settled on land, and residing in houses by themselves, the enumerators enrolled them as *servi ascripti*—inscribed or enrolled slaves—the manifest ancestors of the "serfs ascribed to the glebe," or serfs of the soil, who bulk so largely in the medieval rolls. To register them, though it may have increased their burdens, was to make a legal recognition of their status, and give them a title to the occupation of their land. The law took another step: it forbade a master to sell his slaves unless at the same time he sold the land which they cultivated, nor could he sell his land unless he sold his slaves along with it. A family of slaves was thus allowed to live for several generations on the land originally assigned to them; insensibly they came to be looked upon not as slaves of a master, but as serfs of the soil. It was a great advance. The serf had a house of his own and a family. He was almost a freeman, and might well believe that he was one.

Cultivators of this class doubtless received large accessions as the German immigrants crowded into Gaul. Many also of the smaller proprietors and of the diminishing number of free farmers may have been degraded to serfs. But the change was one of degree; there was no revolution. The new status had originated in Roman times, and only developed as it expanded.

2.—How two radically different social species may branch out from a single stem is well illustrated by a century's growth of the British and the American constitutions. In the last quarter of the eighteenth century these two were substantially alike. The constitution of the United States is known to have been modelled on that of England, but less, as it might have been observed, in its practical working than as it was theoretically expounded. There were two visible differences, of no apparent magnitude, and from these two small variations descend a whole host of differences that have made the two constitutions as mutually unlike as are the constitutions of Germany and Russia. First, the American Executive and the Legislature were rigidly separated. This was partly intentional, but it involved the absence of the Ministry from the legislative chambers, and this was so far from being designed that, after the constitution came into operation, it was for some time debated whether Ministers should be present in either House. It was decided to exclude them, and the exclusion has reacted equally on the Executive and the Legislature. While the English Executive has gradually become the nation acting, and the English Parliament has been slowly transformed into the nation legislating, the Legislature and the Executive in the United States have year by year been drifting further away from identification with the people. The realisation of abstractions has proved as fatal in politics as in philosophy. The Executive acts like an independent organ, and is sometimes (as under Johnson) in flagrant opposition to the popular will, or (as under Cleveland) in but partial sympathy with it. The Legislature has likewise developed along lines of its own. Occult and irresponsible standing committees have bit by bit wrested from Congress the entire power of legislation. In 1790, to obviate some practical difficulties, the House of Representatives assigned the nomination of these committees to the Speaker. This innocent-looking provision made that functionary a true dictator, wielding a more absolute authority than the Czar, while the committees may be compared, for their secrecy and autocracy, to the Venetian Council of Ten. A loyal American, Eugene Schuyler, defines the government of his country as an absolute and irresponsible despotism exercised, under the mask of constitutional forms, by half-a-dozen individuals —the President and two of his ministers, and the Speaker and two chairmen of his nominee committees; in fact, by two individuals.

Nor is this all; a second original variation has been as fruitful of consequences. The President of the Republic, the counterpart of the King, had necessarily to be elected, and the method of election gave rise to the nominating convention. The establishment and growth of this convention are held by so high an authority as E. L. Godkin to "constitute the capital fact of modern democracy in America." Yet there is no record of its origin. None of the earlier or later writers on the constitution allude to it. It was hidden from profound observers like Tocqueville. It came without observation, and grew up in silence and darkness. Its influence was masked in the forties and fifties by the overpowering personalities of Webster, Clay, and Calhoun, who seemed to thwart its behests, and were yet, all of them, its victims During the excitement of the anti-slavery conflict it was but the minister of the popular will. After the war was over it rose into prominence and power. Step by step, it laid an iron grasp on all the machinery of government, and nominated the President, Vice-President, and the federal legislators, the governors and legislators and officers of the states. It was itself then transformed, and, having been omnipotent, it became impotent, surrendering its prerogatives to "the machine," which abandons them to the boss. In most of the states, and in all the larger cities, the boss is king. Here is a second metamorphosis which, together with the first, has made the working constitution radically different from the constitution on paper, and thus created a new political species.

3.—The modern newspaper had a twofold origin. It was a continuation of the manuscript letters composed by professional gossips, and circulated in the provinces, as these letters were the expansion and regularisation of family and coterie letters that had been circulated beyond their first destination. It was also an incorporation of the placards from which people all over Europe derived their knowledge of trade, commerce, amusements, and the odds and ends of life. These soon acquired (at least in France) a vehicle of their own—a printed sheet that was circulated gratis or among subscribers, as merely advertising journals, like the *North British Advertiser* were circulated forty years ago. In course of time the two were amalgamated, and together they formed the advertising and literary halves of the modern journal.

The solitary journal produced by antiquity had a similar genesis, yet not quite the same. The circular letter was rather its midwife than its parent, and the poster from which it really descended was not the popular but the official placard. The part that placards or inscriptions played in the old Roman world is well known. They were the chief organ of publicity. There the emperors inscribed their rescripts, the Senate its laws, and the magistrates their decrees; on them the citizens witnessed their piety towards the gods, their devotion to their sovereigns, and their gratitude to their benefactors; religious corporations thus recorded their fulfilment of their vows, and private individuals registered their contracts. They were graven on brass, marble, or stone, according to their dignity or importance. Over 120,000 of them have been discovered, and by their means historians have revived the life and reconstructed the constitution, the laws, and the religions of the empire. On walls whitened with chalk more perishable memorials of the daily life of the people were traced. It should seem that, in order to create the Roman journal, some enterprising Renaudot (as happened in France) had but to copy and collect the posters of the day. No such evolution took place. Not till B.C. 59, when Julius Cæsar, who had just been elected consul, directed that the minutes of the meetings of the Senate and of the assemblies of the people should be daily placarded, do we find any evidence of the existence of a journal. The *Roman Gazette* was this poster reduced to writing. Educated slaves or freed men many of them Greeks—the ancestors of our reporters—went everywhere in quest of the news eagerly sought for by officials and citizens absent in the provinces. These, it is presumed, were the copyists of the official placards posted daily in the Forum by order of the first and greatest of the Cæsars. By means of the Imperial post the rolls were spread over the vast surface of the Roman world. They were greedily read, and were copiously used by naturalists and historians like Pliny and Tacitus. From fragments of it scattered through Latin writers, Hübner and Boissier have put together that oldest of newspapers, as a naturalist builds up an extinct species. Now mark its evolution. At first solely a report of proceedings in the aristocratic and popular branches of the Roman legislature, as we may call them, it next included the letters and speeches of the emperors and the decrees of the magistrates. A semi-official portion, resembling our *Court Circular*, and mentioning such facts as Cæsar's refusal of a crown and the Imperial receptions on the Palatine, was speedily added. It was soon swelled by accounts of such portents and incidents as a shower of bricks in the Forum, the fidelity of a dog to its master, the suicide of a charioteer, public benefactions, births, deaths, marriages, and divorces—the last at the rate of one per diem. Meanwhile, the original *raison d'être* of the journal had disappeared. The assemblies of the people ceasing to be held, of them there could be no report. Then Augustus forbade the minutes of the Senate to be published. Thus the accessory portion of the journal became its sole constituent, and the original design of the Dictator was both defeated and transformed. Out of a bald record of proceedings had grown a fair similitude of the modern newspaper. The name changed with the thing. At first, *The Acts of the Senate and the People*, it became *The Daily Acts of the Roman People*, and was currently referred to as the *Daily—diurna* or journal. It lasted as long as the empire flourished, but it was an example of arrested development, and it died without leaving offspring.

4.—Literary criticism is still a stronghold of the special-creation theory. So instructed a critic as F. Brunetière alleges that, at a determinable period, and, as it were, at a given signal, the sense of art entered into French literary productions and transmuted them. People wrote prose without art, like Comynes and Margaret; then, all of a sudden, they wrote it with art, like Rabelais. They composed verse naively, like Marot and Saint-Gelais; all of a sudden, like Ronsard, they composed it consciously and like artists. An accomplished dillettante, Th. de Wyzewa, presumably after Mr. Gosse, makes Lodge out to be the "inventor" of five distinct literary species. Similarly, the romance of real life is commonly believed to have sprung suddenly into existence with Defoe. There are sports in literature as among plants and animals, but the modern novel is a species with a long pedigree, which has been traced by a profound student of the English Renaissance—J. J. Jusserand. Its remote sources are the heroic romance and the tale, and it issued from the fusion of the two. In Malory's famous work there is all that we now look for in the novel except living characters and psychological analysis. Yet of the latter there is a glimmering in a dissection of the passion to which the novel owes its existence—the first (says Jusserand) to be found in the prose romance. With Lyly we leave behind us the romance of chivalry and approach the romance of contemporary manners. In "Euphues" the characters have some resemblance to real beings. The tone of conversation is not unsuccessfully imitated. Lyly's opinions on men and life and his analyses of the feelings are ill-fused with the narrative and exhibit the awkwardness of a first attempt, but they are there. The hero of the story is the direct ancestor of Sir Charles Grandison and *his* numerous lineage; and he anticipates, on nobility, love, and the education of children, the ideas that Richardson lends to his characters. Lastly, "Euphues" is the earliest example of that literature of the drawing-room and the parlour to which the contemporary novel is the chief contributor. Lodge and Greene continue the development. In Sydney's "Arcadia" dramatic power for the first time quits the stage and enters the romance. Gynecia is perhaps the first genuine creation in English prose literature. There is constant penetrating analysis of passion, or, at least, of the primary passion. From this story Richardson borrows the name of Pamela and a romantic situation in which she figures.

If Richardson is the lineal descendant of Lyly and Sydney, Thomas Nash is the direct ancestor of Fielding. He, first in England, narrated the history of the picaresque hero, who was born in medieval Germany as Master Reynard, grew up in Spain as Lazarillo and Guzman, came to perfection in France as Gil Blas, and passed over to England as Tom Jones and Roderick Random. With his imaginary characters Nash (like Thackeray) mingles historical figures, and he describes real places and scenes. He paints two or three portraits worthy of Callot or Teniers. Keen observation of humours and oddities makes him an ancestor of Dickens; like Dickens, too, he has the capacity of being moved as he writes. On many lines he is the forefather of the modern novel.

Yet we cannot help perceiving that between Nash and Defoe a whole century lies blank. Shall we say (with Jusserand) that there was only an interruption of fecundity, or (with Brunetière) that there was a breach of continuity? A physiological analogy or identity may throw light on the matter. Like the Australian River Darling, some of whose branches flow underground for hundreds of miles, and come to the surface at long distances only by means of artesian bores, the spiritual germ-plasm unwinds its chain through silent generations or centuries, embodying itself at rare intervals in some individual or production which is not so much the descendant of some earlier production or individual as, like them, the outcome of a common line of development.

5.—The philosopher withdraws to his garret, like Spinoza, or banishes himself to a foreign country, like Descartes, there to excogitate his speculations in silence and solitude. Does not his system spring Pallas-like from his brain, "born without sire or couples of one kind"? Not so. Both can be fathered on past thinkers, and related to the thought of their time. As a more modern example of spiritual transmission we will here briefly trace, after Littré and Paul Janet, the genesis of Comtism. The philosophy of Auguste Comte can be historically affiliated on Francis Bacon. What are the intermediate links? There is a large unbridged gap of a century and a half. Then, in the preface to the great *Encyclopédie* edited by Diderot, we find Bacon's ideas, his organizing genius, his prophetic spirit; it is the *De Augmentis* done into French, developed and expanded; and Bacon himself is there acknowledged as the inspirer of the work. But that preface was written by d'Alembert. From him descend two lines. His pupil and testamentary executor was Condorcet, and from him Comte derived his views on the philosophy of history and the development of the human mind. The other, more important and more fruitful, comes down through the founder of Saint-Simonianism. Saint-Simon alleged that his early education had been directed by d'Alembert. From d'Alembert he acknowledged that he gained the idea of all his scientific works. To him he owed his conception of the unity and organisation of the sciences; like him, he projected encyclopædias.

Now arises the variation. Saint-Simon broke away from the critical and negative philosophy of the eighteenth century, and believed that the time had come to found a constructive and organic philosophy. This philosophy he named the positive philosophy. In various writings he traced its lineaments. All the sciences have begun by being conjectural before being positive; they have become positive in the order of their increasing complexity; they have entered into public instruction as they have grown positive; physiology is on the point of becoming a positive science; ethics will become such a science when it is founded on physiology; philosophy will become such when it is founded on the general facts of the special sciences. Here are the germs of all the principal ideas of Comte—especially of the classification of the sciences and the law of the three stages. The latter was more fully developed by Saint-Simon, and Janet has skilfully followed its traces through a number of his works. In him, too, will be found the Comtist character of science as consisting in verification and prevision, together with other root-ideas of Positivism. Like Saint-Simonianism, Comtism began as a theory of the sciences, advanced to be a social philosophy, and ended as a religious brotherhood. We may well say: no Comte without Saint-Simon; as no Saint-Simon without d'Alembert, and no d'Alembert without Bacon.

THE QUAGGA; A MISSING LINK.

By R. Lydekker.

When the Dutch first colonised that part of Africa of which Cape Town now forms the capital, they found the country absolutely swarming with a great variety of species of large game and other animals, whose form and appearance were for the most part unfamiliar. As they themselves came from a land which had long since been stripped of the larger members of its fauna, it is possible that unfamiliarity with these prototypes was one of the causes which led to the indiscriminate and often inappropriate bestowal of the names of the large mammals of Europe, or compounds of the same, on the animals of the new country. What, for instance, can be more inappropriate than the transference of the Dutch name for elk (eland) to the largest of the Cape antelopes, unless, indeed (which is scarcely likely), the settlers were aware, that etymologically the word signifies, in its Greek original, "strength." Neither is hartebeest (stag-ox) much better, although wildebeest (wild ox) is by no means an unsuitable designation for the animals known to the Hottentots by the title of gnu. Bastard hartebeest, on the other hand, is a cumbrous and senseless name for the antelope the Bechuanas call tsessabe. And it is much to be regretted that the Boers did not see fit to adopt for South African animals the native titles they found ready to hand.

In two instances, and apparently in two instances only, so far as the larger animals are concerned, they did, however, adopt this practice. The first instance is that of the large and handsome spiral-horned antelope now universally known as kudu, a name which is certainly not Dutch, and is believed by Sir Harry Johnston to be of Hottentot origin, since it is unknown to the Kaffirs or other tribes who speak dialects of the Bantu language. The second case is that of the animal forming the subject of this article, which is now universally known as quagga, from a corruption of its Hottentot name quacha, pronounced by the natives as "quaha." Even in this instance, however, the Boers appear at first to have displayed considerable reluctance to adopt the native name, for they originally called the animal wilde esel (wild ass), in the same way as they christened its cousin, Burchell's zebra, wilde paard, or wild horse. Eventually, however, better counsels prevailed, and *Equus quagga* became known to the Cape Dutch by the aforesaid native name, while the wilde paard (whose early title still survives in Paardeberg) was renamed bonte quacha, or striped quagga. When, however, the true quagga became very rare and eventually exterminated, the prefix *bonte* was dropped from the Dutch designation of Burchell's zebra, which was henceforth known throughout South Africa as the quacha, or quagga, pure and simple. Hence much confusion, and possibly also a factor in the extermination of the species to which that title of right belonged. For as the name in question continued to be in common use in South Africa at the time the true quagga was on the point of extermination, it is quite probable that this may have been the reason why the attention of naturalists in Europe was not drawn to its impending fate while there was yet time.

According to the best attainable evidence the quagga appears to have become extinct, in Cape Colony, at any rate,* about the year 1865, at which date a specimen

* From the fact that a skin was purchased by the Edinburgh Museum in 1879, Mr. G. Renshaw (*Zoologist*, February, 1901) has suggested that the species may have survived in the Orange River Colony till about that date. I am informed, however, that the specimen was believed to be an old one at the date of its purchase from a dealer.

THE LAST OF THE QUAGGAS.

(From a Photograph by Messrs. YORK & SONS).

was actually living in the London Zoological Society's menagerie; while another had died there only the year before. Of the latter example, a male, presented to the Society in 1858 by the late Sir George Grey, the carcase was fortunately acquired by the British Museum, where both its skin and skeleton are now preserved. The former specimen—a female purchased in 1851—survived till the summer of 1872, when its carcase was sold (apparently without the least idea of its priceless value) to a London taxidermist, from whom the mounted skin was acquired many years after by Mr. Walter Rothschild, for his museum at Tring. This specimen was apparently the last survivor of its kind, although, as already said, there was not even a suspicion that it belonged to a rare species. Most fortunately for natural history two or more photographs of this animal were taken in the summer of 1870 by Messrs. York and Son, and it is from these photographs (one of which is herewith reproduced) that most of the later figures of the animal appear to have been taken. They are probably the only photographs of a living specimen in existence.

According to a note published by the Secretary, in the *Proceedings* for 1891, the only other example of the quagga in the London Zoological Society's menagerie was one purchased in 1831. No record of its death appears to have been preserved, but it may have been the same specimen of which the skin was exhibited in the Society's old museum in 1838, or thereabouts. These, however, were by no means the only specimens brought alive to England, for as early as 1815 one was in the possession of Lord Morton, while somewhat later on in the last century Mr. Sheriff Parkins was in the habit of driving two quaggas in a phaeton about London, and in narrating this circumstance the late Colonel Hamilton Smith mentions that he himself had been drawn in a gig by one of these animals, which showed "as much temper and delicacy of mouth as any domestic horse." Another quagga was in the possession of a former Prince of Wales, and there are records of others in England. The skulls of the two driven by Mr. Parkins, as well as a portrait of one of them, are preserved in the museum of the Royal College of Surgeons.

In addition to the specimens in the British, Edinburgh, and Tring museums, several skins are preserved on the Continent. With one exception, all appear to be of the same general type as the London example photographed by Messrs. York in 1870. The exception is one in the Imperial Museum at Vienna, of which a description and photograph have recently been published by the Director, Dr. L. von Lorenz, in the *Proceedings* of the Zoological Society of London. Unfortunately there is no record as to the locality where the Vienna specimen (which is a female) was obtained, all that is known being that it was acquired by purchase in 1836.

Compared with the ordinary type of quagga, as exemplified by York's photograph, the Vienna animal is of somewhat larger dimensions, with a creamy buff (instead of greyish or chocolate-brown) ground-colour on the upper parts, with the exception of the head, which is clay-brown. A more striking difference is to be found in the broader dark stripes (of which there seem to be more in a given space), and a corresponding decrease in the width of the intervening light intervals. The stripes also seem to extend farther back on the body.

But there is also a difference between quaggas of the type of the one photographed by York and those figured by the early writers, as exemplified by the plate in Colonel Hamilton Smith's volume on horses in the *Naturalist's Library*. In the specimen there represented, which not improbably came from Cape Colony, and may be regarded as the typical form of the species, the head, neck, and forequarters are marked by narrow black stripes on a chestnut ground. The markings are, indeed, as Dr. von Lorenz remarks, just the reverse of those of the Vienna specimen; the British Museum example, and the one figured by York being in some degree intermediate between these two extreme types.

With some hesitation, Dr. von Lorenz suggests that there may have been local races of the quagga, as there are of Burchell's zebra. Regarding Hamilton Smith's plate as representing the typical Cape quagga, the two other forms probably came from districts farther to the north, and the suggestion may be hazarded that the Vienna specimen, as the more aberrant, was obtained from the Orange River Colony or Griqualand West, forming the northern limits of the range of the species. For the race typified by the British Museum specimen the name *Equus quagga greyi* would be an appropriate designation, while for the one represented by the Vienna example the title *E. quagga lorenzi* may be suggested.

But it was not my intention when commencing this article to enter into a discussion of local races, but rather to point out what an interesting animal the quagga really was, and how great a loss its extermination has been to zoology.

Even in the days of its abundance the quagga (which, by the way, takes its name from its cry) had a comparatively limited distribution, ranging from the Cape Colony up the eastern side of Africa as far as the Vaal River, beyond which it appears to have been unknown. In this respect it closely resembled the white-tailed gnu, which, however, is known to have crossed that river in one district. Curiously enough the two species lived in close comradeship, and in the old days their vast herds formed a striking feature in the landscape of the open plains of the Orange River Colony. Both have now disappeared from the face of the country, for the white-tailed gnu, if, indeed, any are now left, only exists in a semi-domesticated state on a few farms.

Owing to its rank flavour, and especially its yellow fat, the flesh of the quagga was almost uneatable by Europeans, although it was keenly relished by the Hottentots, who, in the early days of the Cape Colony, were largely fed upon it by their Dutch masters. Whether this was the cause of its comparatively early disappearance from that part of the country, it is now impossible to say, but certain it is that when Sir Cornwallis Harris made his trip to the interior, in 1836, quaggas were no longer to be met with in any numbers in Cape Colony, although Colonel Hamilton Smith, writing a few years later, states that they were still to be found within its limits. North of the Vaal River they occurred, however, in their original multitudes, and it was not till about the middle of the last century that the Boers took to hide-hunting, and thus in a few years accomplished the extermination of the species.

Allusion has already been made to the facility with which the quagga could be broken to harness, and it seems probable that the species could have been more easily domesticated than any of its South African relatives. Another trait in its disposition is worth brief mention. It was said to be the boldest and fiercest of the whole equine tribe, attacking and driving off both the wild dog and the spotted hyæna. On this account the Boers are stated to have frequently kept a few tame quaggas on their farms, which were turned out at night to graze with the horses in order to protect them from the attacks of beasts of prey.

Throughout the whole of the plain country to the south of the Vaal River the quagga was the sole wild representative of the horse family, the true zebra being confined to the mountains of Cape Colony and adjacent districts. North of the Vaal River the veldt was, however, dotted over with herds of Burchell's zebra, the aforesaid bonte-quagga, which (inclusive) of its local races, has a very extensive geographical distribution in East and Central Africa. It is scarcely necessary to say that this species differed from the true quagga in having the whole body striped, as well as by its much more brilliant type of colouration and the pattern of the striping. One very remarkable feature in connection with this species must not be passed over without notice. In the original and typical race (now apparently extinct), which was obtained just north of the Vaal River, in British Bechuanaland, and therefore immediately adjacent to the northern limits of the quagga, the whole of the legs, as well as a considerable portion of the hind-quarters, were devoid of stripes. In this respect the typical form of the Transvaal species came much nearer to the last-mentioned animal than do the races from more northern districts, in which the hind-quarters and legs are more or less completely striped; the striping attaining its fullest development in the most northern race of all, the so-called Grant's zebra of Somaliland and Abyssinia.

Of course, these gradations towards the quagga-type of colouration of the more southern representatives of Burchell's zebra, as well as the difference in the colouration of the quagga itself as compared with zebras, have a meaning and a reason, if only they could be discovered. And it may be remarked incidentally in this place that unless we attempt to account rationally for such variations there is little justification for the modern practice of distinguishing between the local races of variable species.

The striping of the zebras, which there is considerable cause for regarding as the primitive type of colouration of the horse family in general, is evidently of a protective nature. It was stated some years ago that zebras a short distance off are absolutely invisible in bright moonlight, and I have reason to believe that the same is to a great extent the case in sunlight. For some reason or other the species inhabiting the plains (not the mountains, be it observed) of South Africa have tended to discard this striped colouration, the southern race of Burchell's zebra exhibiting the first, and the quagga the second stage in this transformation. In North Africa the transformation has been carried a stage further, the wild asses of the Red Sea littoral having discarded their stripes almost completely in favour of a uniform grey or tawny livery. In this part of the continent there is now no trace of a transitional form, whatever may have been the case in the past, and we thus have the sharp contrast between the uniformly coloured wild asses of the coast of the Red Sea on the one hand, and the fully striped zebras of Abyssinia and Southern Somaliland on the other.

Whether there is anything in the climatic and other physical conditions of the plains of Cape Colony which renders a partially striped species less conspicuous than one in which the striping is fully developed, the disappearance of the quagga makes it now impossible to determine. But observation might advantageously be directed to the comparative invisibility, or otherwise, of the wild asses of the Red Sea littoral and the fully striped zebras of the interior, and whether this would be affected in any degree by the transference of the one to the habitat of the other. Whatever be the explanation, the fact remains that at the opposite extremities of Africa some of the members of the equine tribe have developed a tendency to the replacement of a striped livery by one of a uniform and sober hue, and that in the south of the continent this tendency exists only in the species inhabiting the plains. Moreover, it is only in South Africa that the transitional form is met with, and only in the north of the continent that the striping has been completely lost.

But this is only one phase of a general tendency among mammals to replace their spots or stripes by a uniformly coloured coat, as is exemplified by the case of many deer, pigs, and tapirs, as well as by the lion and the puma among the Carnivora.

So far as I am aware, no one has ever attempted to give a philosophical reason for this remarkable tendency. But till an adequate explanation of the phenomenon be forthcoming, naturalists, to repeat the words of a well-known ornithologist, have left half their work (and I am inclined to think the more important half) undone. Without ascertaining the reason for phenomena of this nature our zoological work is, indeed, as though a man were content with describing the mechanism of a complicated machine without an inkling as to its use.

One word more, and I have done. To the systematic zoologist, the quagga is an animal of special interest as affording evidence of the intimate relationship between the zebras and the wild asses. Although, judging from its geographical distribution and its physical characteristics, it was probably not the actual transitional form between the striped and the uniformly coloured species, yet it serves to show the manner in which the transition was effected. In this sense it is undoubtedly a link, and since it is now, unhappily, missing from the roll of living animals, the reason for the title of the present article will be apparent.

ACROSS RUSSIAN LAPLAND IN SEARCH OF BIRDS.

By Harry F. Witherby, F.Z.S., M.B.O.U.

IV.—IN THE BIRCH SCRUB AND ON THE ROCKY COAST.

The concluding portion of my last article* found my companion and myself amongst the marshes near the northern end of the great Imandra Lake.

Our limited food supply continually drove us forward, so that however interesting a place might be we could never afford to stay there long. Rowing to the head of the Imandra, we landed at the mouth of a small river which flowed into the lake. The river was full of rapids, and could not be ascended by a boat, so we walked across country to a little lake, which the river connected with the Imandra.

Crossing this lake—the Pereyaver—we arrived at an interesting water parting. An almost level strip of land of only some five hundred yards across separated two chains of lakes and rivers—the one up which we had travelled flowed southward and reached the White Sea, while the other rushed northward and found an outlet in the Arctic Ocean.

At this spot we were attacked by vast swarms of blood-sucking flies, so small that they easily passed through the mosquitoe veils, and so voracious and poisonous that we were soon suffering from swollen glands and intense ear-ache. We were forced to pack up and flee northwards, camping eventually on the shores of the Pulozero. Here we found unexpected civilization in the shape of a well-built telegraph station, inhabited by a most hospitable official, who treated us with every kindness. Although somewhat short of flour himself, he provided us with bread, which we sorely needed, and in the way of luxuries he had his bath house heated and prepared for our use.

* *See* Knowledge, June, 1902.

This gentleman was very anxious that I should take his portrait, and notwithstanding my protestations that the picture probably would be unsuccessful, and at all events small, he insisted upon dressing up in his full uniform which included a sword and a medal. One of the telegraph line inspectors was proclaimed to be a great sportsman, and was anxious to take us to some marshes at some distance, which he reported to be the haunt of wild geese and swans. We gladly accepted his services as guide, and taking a few men and our tent we set off for the marshes. The walk thither was most trying, as it was pouring with rain, and we had to wade for miles uphill through slush and soft moss. The marshes, however, were extensive, and were the breeding haunts of a number of interesting

Fig. 6.—The Telegraph Sportsman and Gregori (interpreter) at Pulozero.

wading birds, amongst others being the dusky redshank, and the bar-tailed godwit, which were mentioned in my last article. But we never saw a sign of a goose or a swan, and our guide's sporting achievements were none too brilliant. He stayed for a long time at the edge of a small lake, and fired many rounds at a flock of ducks fully two hundred yards away. Soon afterwards I saw him fire twice at something on the ground, and on reaching him I saw that his mark was a fluffy little greenshank. On catching the chick we found one of its toes slightly injured by the shot.

As we journeyed northwards from Pulozero the character of the country gradually changed. The pine forest became thinner, and the birch trees more numerous until the pine trees eventually disappeared. Then the birch trees in their turn become scarcer and stunted, and the dwarf birch and many other kinds of creeping plants began to get the upper hand, until at the coast the only trees were a few wind-blown birches, while even the creeping plants in many places were unable to exist, and reindeer moss, hoary and luxuriant, reigned in their stead.

The change in the vegetation had a marked effect upon the bird life. For instance the capercaillie disappeared with the pine forest, and willow grouse* increased in numbers as the country became more open. The plumage of the willow grouse especially interested us. This bird is familiar to all in its winter garb of white when it appears in the poulterers' shops under the name of ptarmigan. In summer, however, its plumage is brown, much like that of the red grouse, except that its wing feathers always remain white. In high northern altitudes where spring, summer, and autumn are crowded into a few months, the bird often retains part of its white plumage, especially on the breast, throughout the summer; so that we were not surprised to find all the willow grouse bearing old winter feathers in August. But when we came to examine these birds we discovered that they were still in the midst of the "spring" moult, their breasts and backs being covered with new and growing feathers, many of them only just peeping through the skin. It seemed doubtful that these birds would complete this moult that year before the winter plumage became necessary, for already new snow was falling on the hills, the mosquitoes were fast dying, and autumn had commenced. The exceptionally late summer accounted, no doubt, for this curious state of plumage, and as we journeyed north other anomalies caused by the backward season were apparent.

Most of the willow grouse had broods of very small chicks, and, like other gallinaceous birds, the parents were active in using various devices to attract the intruder's attention while their young ones were rapidly getting under safe cover. To give a few instances. I was watching a hen bird feeding her chicks which were jumping up to her beak and pecking bits of food from it. Suddenly she saw me, and uttering a harsh and low chuck she began to run like a rat through the grass and undergrowth, but keeping always in full view. Meanwhile her chicks had scattered in every direction and had disappeared like magic. One old hen which I came upon very suddenly, rushed up to me cocking her tail and holding her head as bravely as a bantam, she was so defiant, and came so close, that I thought she was going to strike me. The cock birds were as eager to protect their young as the females. Once, on surprising two old birds together with their brood, the hen immediately made off, but the cock flew straight at me and fell over, as though shot, almost at my feet. He quickly picked himself up, and, crouching low, crept away dragging his drooping wings along the ground.

At Kitsa, where two log huts formed a "station," the food question became acute. We had run matters rather fine in our desire to stay as long as possible in the country, and now we had but a tin of tongue left for ourselves and nothing for our men. However, fortune favoured us, for at the foaming junction of two rapid rivers we caught a fine salmon, and higher up one of the rivers a good trout and a pike. They were soon cooked, and our men ceased grumbling, while we were glad to have a substitute for tinned food. Nevertheless, we hurried forward to Kola, a small village of wooden houses, and the capital of Russian Lapland.

Historically Kola is famed for having been bombarded (inoffensive and unprotected fishing village as it is) by a British gunboat during the Crimean war. It is prettily situated at the base of a hill, flanked on both sides by rivers flowing into a fjord, which takes its name from the village. Here we were once again in communication with the outside world. We paid off our men, who set off back to their homes by the way we had come. They had no loads, but their pockets were heavy, their pay being in silver, and their hearts were glad, while as to their heads I am afraid they were lighter even than usual, for until Kola was reached the men had long abstained from vodka.

We found plenty to interest us during the two days which we spent in Kola while waiting for a steamer to take us down the fjord. Most of the inhabitants were

Lagopus albus.

away fishing on the Murman coast, but the people who were left were very nice, and a great contrast to the peasants of Kandalax. They seemed to be happily influenced by their proximity with Norway. A little boy to whom I gave a copek for bringing me a telegram, took of his hat and shook my hand in true Norwegian fashion.

I should not dare to boast of my own culinary efforts, but my companion had for a month proved himself an excellent *chef*. Nevertheless, it must be acknowledged that on boarding the steamer which was to take us to the coast, we took a very great interest in the wonderful dishes put before us (and not in vain) at the first few meals.

We had determined to work in the neighbourhood of the coast for a week, so we disembarked at Ekaterina—a remarkable place at the mouth of the Kola Fjord. The harbour of Ekaterina is practically land locked, and thus well protected from all winds. Moreover, by the kindly influence exerted by the Gulf Stream it is the most easterly harbour in the north of Europe which is free from ice at all seasons, and is thus the only northern port possessed by Russia which remains unfrozen in the winter. Though the water is deep the harbour is small, being only about a quarter of a mile wide. It would not, therefore, be convenient for large war vessels which could not easily turn in it. Nevertheless, the Russian Government have here built a small dry dock, and at great cost have constructed a fine road up the rocky slope which descends abruptly to the water's edge. The road leads to the only level piece of ground on the hills round the harbour. This was a small marsh, but has now been drained, and some fifty wooden buildings forming the new town of Ekaterina have been erected upon it. These buildings were all made in Archangel, and brought thence in parts. They include a fine church, a custom house, a school, and other public offices. During our journey through Lapland, Ekaterina had just been completed, and had been opened officially with great ceremony.

We spent a most enjoyable week here, being most hospitably entertained by a party of Russian marine biologists, who were installed in a well-fitted laboratory. Although the weather was wretched we much enjoyed the bracing air of the coast after the muggy atmosphere of the interior. We were able to add considerably to our collection. The most remarkable point about the birds on this rocky northern coast was the fact that many of them still had nests with fresh eggs, although the winter was coming on apace. Mealy redpolls* were common amongst the stunted birch trees, which struggled for an existence in the dells amongst the rocks, where they were more or less protected from the winds. Most of the redpolls had fresh eggs in their beautiful little nests, and I feel sure that these were first broods, for I saw no young birds about. One nest contained a dead bird sitting on two eggs. On dissecting this bird it was evident that it had died "egg-bound," which I fancy must be a rare occurrence amongst wild birds.

One day we saw a diver flying over a hill. As we watched, it began to circle, and eventually flew down behind the hill. We crept over the slope, and found a small tarn on the other side, and seeing no bird about we concluded that it had gone on to its nest. So we separated and walked carefully round the small lake. I had not gone far before a large bird slid silently off the bank into the water. Swimming rapidly for a short distance, it suddenly raised its body perpendicularly in the water, and flapping its wings began to croak loudly. As I wanted the bird I did not delay long in shooting it, knowing well from experience that when once these birds begin diving it is next to impossible to get them. The bird proved to be a red-throated diver.* On the bank from which it had slid were two fresh eggs, placed in a depression in the wet moss within a foot of the edge of the tarn. From the nest to the water was a shallow trough worn in the moss by the bird which was accustomed to slide from its eggs down into the water. My friend and I waited patiently

Fig. 7.—Red-throated Diver on Nest.

in turns for many hours well hidden near the nest, hoping that the other bird would come to the nest. But it never appeared, although its mate which we had shot proved to be the male. The photograph here reproduced is one of the dead bird on the nest, and was taken in the pouring rain.

Bidding adieu to our kind Russian hosts we sailed for Vardoe. Here we had to wait six hours for a steamer to take us south, and during that time we employed ourselves most profitably in collecting birds. We found a number of interesting species congregated in a field attached to a small fort. On one side some soldiers were drilling, on the other a sentry was pacing up and down. Still we were determined to have those birds, and accordingly climbed over the fence and proceeded to get them. In our eagerness we had soon forgotten the sentry, and were surprised after shooting some six or eight birds to see him buckling on his sword and running towards us. Pocketing the birds, as well as the little poaching gun which we had been using, and climbing out of the field, we went to meet the little man in the most innocent way. However, he received us with an awful torrent of what sounded like abuse. We were both most ignorant of the Norwegian language, and the only expression I could think of as at all benefiting the occasion was a word sounding like "umflelardles," and signifying "I beg your pardon." Accordingly I repeated this word many times in the suavest possible way, and then we walked rapidly away to our boat, leaving the soldier in a most indignant rage. Unluckily some boys had seen and heard the whole of the fun, and they followed us through the town shouting out the tale, and repeating some of the sentry's choicest expressions, as well as my apology, which seemed to cause the inhabitants great amusement. We were well able to join in the laugh, because our hare pockets bulged conspicuously with a rich booty.

. . . .

* *Linota linaria.*

* *Colymbus septentrionalis.*

How tame and artificial seemed the pleasures and luxuries of civilization soon after our return home. How we sighed for the wild freedom of camp life. Little hardships, and even the tormenting mosquitoes of Lapland, were forgotten in a feverish longing to roam once more over some country untouched by man—the desire to be alone with Nature in her wildest aspects was our strongest passion.

NEBULOUS STARS AND THEIR SPECTRA.

By Miss Agnes M. Clerke.

With his great photographic binocular, Dr. Max Wolf secured, in July, 1901, two simultaneous impressions of the extraordinary object named by him the "America" nebula. One, lately reproduced in these pages, has excited the wonder and admiration of all competent judges; the second has not yet been published. The comparison of the twin pictures would be of extreme interest. To take just one example. Even a cursory examination of the July plate shows the nebulous light to be interrupted, often where it is brightest, by isolated spots of absolute blackness, round or oval, and sharply terminated. Their identification in the companion-photograph would leave no doubt of their objective reality. The peculiarity is the more noteworthy from its extensive sidereal prevalence. Stellar and nebular formations are alike liable to perforation; whether as an incident in their development, or through the action of external forces, we cannot pretend to determine. The pits and chasms in the Trifid Nebula strike the eye at once in the beautiful pictures obtained by the late Prof. Keeler with the Crossley reflector. Dark areas and "black, tortuous rifts," assert their presence emphatically on Dr. Roberts's plates of the nebulous cluster in Monoceros,* (N.G.C. 2237-9). The "Key-hole" Nebula manifests the same characteristics on an enlarged scale; while the Milky Way itself bears witness to its dominance over the distribution of cosmical masses to the utmost bounds of the visible universe. Moreover, globular clusters are apt to be riddled with "holes." Prof. Barnard's recent study of M. 5 Serpentis, with the forty-inch Yerkes refractor, brought to his surprised cognisance a number of "inky black spots," close south-preceding and south-following, the densest part of that singular aggregation.† He had, indeed, been previously aware of the presence in M. 13—the great Hercules cluster—of similar disaggregative symptoms (if as such we are justified in interpreting them). Nor are they absent from nebulous stars. The luminous halos surrounding these rare objects are not, as a rule, symmetrically disposed. They are frequently irregular and heterogeneous, and show vacancies and mottlings altogether inconsistent with the supposition of their condition being one of statical equilibrium.

Nebulous stars probably represent the earliest phase of stellar evolution. They irresistibly suggest incipience; they have seemingly not yet fully appropriated the material allotted for their construction. In the course of a few or of many millenniums, they will, it is reasonable to suppose, have absorbed the outstanding supply and will shine as finished suns. Hence, particular importance attaches to the investigation of spectra emanating, presumably, from inchoate photospheres. For the ascertainment of their nature serves to determine, with approximate security, the starting-point of the grand process by which suns grow and decay. And, judging from the scanty information so far available, this starting-point is from stars marked by helium-absorption. By helium-absorption, associated—as Mr. McClean and Miss Maury independently concluded—with light-stoppage by all the three series of hydrogen, by oxygen, perhaps invariably, and very frequently by nitrogen and silicon. The action of metals is, in these early spectra, quite inconspicuous, and metallic rays form no part of the emissions of gaseous nebulæ, so that the prominence of metalloids in stars of itself suggests their proximity to a nebulous condition.

Now the spectra of stars with nebulous appurtenances are mainly impressed with dark lines of helium, hydrogen, and oxygen. It is too soon to pronounce the rule an invariable one; but until some one exception to it has been established, it may be admitted as a provisional generalisation. At the first sight of Dr. Max Wolf's photograph (already adverted to) of the "America" nebula, such an exception seemed to present itself; for the strongly nebulous star close to its western border was named in the text ξ Cygni, and ξ Cygni shows a spectrum of the solar type. Further enquiry, however, proved that there had been an accidental error of identification, and that the star in question is no other than 57 Cygni, the spectrum of which has the letter "B" affixed to it in the Draper Catalogue.* This means that it shines with the "Orion" quality of light; and on turning to the supplementary remarks, we note the record of a distinctive line of cosmic hydrogen, in addition to those of helium and of vacuum-tube hydrogen. The real ξ Cygni lies on the *Pacific* side of the nebulous continent—looking at it as if it were depicted on a terrestrial map—and in about the latitude of San Francisco. But in the ocean of space it is probably situated indefinitely nearer to us than the nebula projected beside it upon the sensitive plate. It may, in actual fact, be just as completely disconnected from it as a reticle from the celestial bodies it serves to divide and define.

This cannot be said of the diffuse object off the *Atlantic* shore of the nebula. Prof. Wolf states that, in the original negative, "many interesting arms and wings of nebulosity" can be perceived to radiate from it. And, although he does not assert categorically their organic relationship with it, the chance of the fortuitous production of an arrangement so express and particular must be regarded as extremely remote. It is, indeed, admittedly difficult to discriminate, in long-exposure photographs, between stars genuinely and stars only optically nebulous, yet the visible origination of nebulous appendages can scarcely be fictitious. Thus, the situation of 57 Cygni, with regard to the filmy protrusions apparently issuing from it, is too critical to be casual; and, as we have seen, the spectrum of the star corresponds perfectly with a nebulous condition.

Its brightness—4·6 magnitude—is almost that of ω Orionis, detected as nebulous, both photographically and visually, by Barnard in September, 1893 (Knowledge, Vol. XVII., p. 17). The two stars are also spectroscopically alike; they constitute similar foci of nebulous concentration; each would seem to be a diffuse globe but recently equipped with the machinery requisite for intense radiation. With them may be classed σ Scorpii, one of the finest nebulous stars in the heavens, described by Barnard as structurally involved in the great Rho Ophiuchi formation; ϵ and ι Orionis, the "atmospheres" of which were noted by Sir John Herschel; and λ Orionis, disclosed as haze-encompassed by a long fixed stare with Barnard's Willard lens. This object is one of Struve's pairs (Σ 738); the

* "Celestial Photographs," Vol. II., p. 171.

† *Astr. Nach.*, No. 3519.

* Dr. Max Wolf desires to acknowledge Miss Clerke's correction, and would ask readers of Knowledge, in his article on page 156 of Knowledge for July, 1902, at the 20th line, *for* "ξ Cygni," *to read* "57 Cygni."

components, of respectively fourth and sixth magnitudes, are 4″·2 apart, and display—or, at least, displayed to early observers*—contrasted tints of yellowish and purple. The pure radiance, nevertheless, of a Golconda diamond would match better their joint spectrum. It is of a highly primitive pattern; the lines crossing it are few and diffuse; and they claim, all but exclusively, a metalloidal origin. Those of helium, together with the Huggins and Pickering series of hydrogen, are unmistakable,† and absorption by oxygen and nitrogen will assuredly be found when carefully looked for.

One apparent anomaly remains to be mentioned. A 5·5 magnitude star in Scutum Sobieski (B.D. 10° 4313) came out on one of Barnard's plates in 1892, surrounded by an extensive tenuous halo.‡ Yet in the Draper Catalogue, where it is enrolled as No. 8198, a spectrum of the Capellan variety is assigned to it. Assigned, indeed, with some hesitation; still we cannot but note the confirmatory circumstance that the star is fainter chemically than optically, while in helium-stars an opposite disparity is always observed. A single good spectrograph would settle the point. Nor should the genuine nebulosity of the object be admitted on the unsupported evidence of an isolated negative. Verification should be sought by repeated and varied exposures, for the question whether a solar star can be nebulously involved is really fundamental to theories of relative stellar ages.

It might have been anticipated that nebulous stars would be found to shine predominantly by emission—that bright lines would be conspicuous in their spectra. Facts, however, do not bear out this forecast. An immense majority of bright-line stars are entirely free from nebulous entanglements. The conditions are combined, and that imperfectly, only in the stars of the Orion trapezium, which give feeble signs of spectral emission; and in two members of the Pleiades group, Alcyone and Pleione, neither of which is in such immediate connection with nebulous structures as some of their dark-line associates. Nor is there at present any reason to suppose that the nuclear stars which, in planetary and annular nebulæ, appear the very foci of constructive activity, emit gaseous radiations. Those that do—and they are very few—are palpably not stars, but condensed wisps of cosmic haze. Experience does not then warrant the current surmise that the first stage of stellar development is marked by a bright line spectrum. The requirements for its production would rather seem to be independent of age, and to arise under special influences, or through exceptional peculiarities of constitution. But the topic, being one of the most arduous in astrophysics, is emphatically one upon which dogmatic pronouncements would be out of place.

ASTRONOMY WITHOUT A TELESCOPE.

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

XVIII.—VARIOUS SKY EFFECTS.

THERE are certain phenomena which lie very near the border line of astronomy and meteorology; so near that it is difficult to say which science has the stronger claim to take note of them. Amongst these, perhaps, those which have the best claim to be included in the department of astronomy are the strange bright clouds which were discovered by Ceraski, and which were afterwards made the object of careful study by O. Jesse. These Luminous Night Clouds were utterly unlike any phenomenon which had been previously recorded, and their discovery, like that of the Gegenschein, was a striking evidence that not even yet have the fields of work which lie close at hand been all explored. There is still an ample harvest to be reaped in more than one direction by the man who can reinforce an observant eye by thoughtful patience.

These luminous clouds were not visible at every time of the year, but only during the nights of summer; their period of visibility for Berlin, where Herr Jesse observed them, being from May 23rd to August 11th; a period corresponding nearly to the season of continual twilight for that latitude. Their light was derived from the sun, which during that season is never more than 18° below the northern horizon, and the rays of which they were enabled to catch by their great height above the surface of the earth; for the comparison of photographs taken of them from different stations showed that they ranged from fifty to fifty-four miles in elevation, or ten times the height attained by light cirrus clouds.

In appearance these night-clouds were of a brilliant silvery-whiteness, slightly tinted at times with blue if near the zenith, or with a reddish-yellow tinge if near the horizon. They were woolly and striated in character, and repaid examination with a field-glass of large aperture, by means of which they might be traced considerably further than the naked eye could follow them.

The discovery of an order of clouds at a height above the earth so greatly exceeding anything which had ever been observed, even of the lightest cirrus, was remarkable enough. More remarkable still were their variations. For they were not by any means a permanent phenomenon, and diminished in frequency of appearance from the time of their first discovery. From 1885 to 1889, they were seen before midnight; later they could only be detected in the morning hours. Their movements were more interesting still, and were such as might be caused—so it has been suggested—if, though travelling with the earth, they were but lightly subject to its attraction, and experienced some retardation as they travelled with it.

From any point of view the existence of these clouds must be regarded as most remarkable. That clouds should exist at all at a height greater than the highest stratum to which we owe twilight, and that so existing they should be an occasional and variable phenomenon are entirely unexpected discoveries, and still remain unexplained. Can it be that they are one of the by-products of the great volcanic eruption of Krakatoa in 1883? If so, they may be looked for after any great series of volcanic outbursts, such as that which commenced with the destruction of St. Pierre in Martinique in May, 1902, even though these eruptions cannot compare in violence with that of Krakatoa.

Three striking sky-effects followed that great eruption of 1883. The first was comparatively restricted both as to area and time, and took the form of a remarkable colouration of both sun and moon. At Batavia, in Ceylon, at various places in India, the sun was seen to be blue or green; blue when at the zenith, changing through green and yellow to total obscuration near the horizon. A much more lasting effect was that which received the name of "Bishop's Ring," having been first reported from Honolulu by the Rev. S. E. Bishop on September 5th, 1883. This ring was a remarkable species of halo to be seen on every fine day surrounding the sun from its rise to its setting, and even occasionally round the moon. Thus in the Stonyhurst Observatory report for 1883, it is stated: "During the day the sun is invariably surrounded by an intense silvery brightness slightly tinged with green, and at a distance of about 20° from the sun this tint sometimes changes gradually into a pink or pale violet, and fades

* Webb, "Celestial Objects," Vol. II., p. 182, Espin's ed.

† A. C. Maury, "Harvard Annals," Vol. XXVIII., p. 111.

‡ *Astr. Nach.*, No. 3111.

away at about 45° . . . an orange tinted haze extending about 45 from the moon was also seen on several nights towards the middle of December." There can be no doubt that "Bishop's Ring" was a diffraction effect due to an immense quantity of dust particles of an extreme minuteness driven up by the great explosion to a great height in our atmosphere and slowly subsiding. For as late as 1887 the ring still remained, though it could then be only traced as a peculiar white haze to a distance of about 10° from the sun.

The third result of the eruption of Krakatoa was the occurrence of "Afterglows" at sunset and "Foreglows" at sunrise. These were distinguished from normal sunsets and sunrises in that they differed from them in the time of their appearance and the place or quarter in which they were formed; in their periodic action or behaviour; in the nature of the glow, which was both intense and yet lustreless; in the regularity of their colouring; in the colours themselves, which were impure and not of the spectrum; and, lastly, in the texture of the coloured surfaces, which were neither distinct cloud of recognised make nor yet translucent mediums. The regularity of their colouring was particularly striking. "Four colours in particular have been noticeable in these afterglows, and in a fixed order of time and place—orange, lowest and nearest the sundown; above this, and broader, green; above this, broader still, a variable red, ending in being crimson; above this, a faint lilac. The lilac disappears; the green deepens, spreads, and encroaches on the orange; and the red deepens, spreads, and encroaches on the green, till at last one red, varying downwards from crimson to scarlet, or orange, fills the west and south."*

These magnificent afterglows reappeared, but on a diminished scale, after the Martinique eruption of May, 1902. A valuable letter by Prof. A. S. Herschel appeared in *Nature* for July 24th, 1902, describing the afterglow of June 26th. The sun set about 8h. 25m., and a quarter of an hour later a long low belt of sky in the N.W. had grown orange-yellow, whilst the ruddiness of the sky in the east had by the same time risen nearly to the zenith. Between the two there lay a white tract about 30° in width, which was gradually invaded and at last quite occupied by the advancing ruddy colour from the east. About 8h. 55m. from the zenith down to 30° above the place of sunset, and for 40° or 50° on either side of the vertical line through it, was a broad expanse of rich, rose-coloured, lake-red light. This red glow sank rather rapidly in height, and by 9 p.m. it had subsided into a brighter glow near the horizon.

The colour effects of an ordinary sunset are due to the depth of atmosphere through which the sunlight reflected to us from the clouds has passed before illuminating them. In their passage the rays of short wave-length suffer a greater scattering, and are therefore lost to us in a greater proportion than those of greater wave-length, with the effect of producing a golden or ruddy glow. The afterglow would appear to be due to the intervention of a reflective stratum at a greater height than that of ordinary clouds. In 1883 this was no doubt composed of the finely-divided volcanic dust to which "Bishop's Ring" had been due, suspended high in our atmosphere, and no doubt the afterglows of 1902 owed their origin to a similar cause. The height of that stratum can be inferred from the depression of the sun below the horizon at the time when the further boundary of the glow is setting, or is at some definite altitude, or from the elevation of the zones of its greatest brightness. In this way Prof. Herschel found the elevation of the reflective stratum on June 26th as about five miles; whilst on June 28th, he estimated "the sun's parting illumination of the sky to rosy colour" at not much more than 30 minutes after sunset, and the height of the dust stratum in consequence as about 7½ miles.

These intervals were very distinctly shorter than those remarked in 1883 and 1884. The primary glow after Krakatoa averaged 54 minutes after sunset until its disappearance on the horizon; the secondary averaged 96 minutes. If the secondary glow be due to direct sunlight, the average height of the stratum causing it must have been nearly 40 miles. But if, as appears more probable, the secondary glow was due to the same stratum as that which produced the primary, being in fact a second reflection from it, then the mean value of its height would be about 11 miles.

On a bright clear evening, as the sun goes down, an interesting phenomenon may often be watched. If the observer turns his back on the sun, he will see in the east, immediately after sunset, a long dark line spread along the horizon. This darkness, which is indeed "the Shadow of the Earth," thrown upwards as the sun goes down, rises somewhat rapidly, its upper edge, under favourable circumstances, being quite sharply defined. This "shadow of the earth," which may be made out more or less distinctly on any clear evening in a suitable locality, and which is especially easy to watch at sea, revealed itself in a very interesting manner in the case of the luminous night clouds described in the beginning of this chapter. If the clouds were seen in the earlier portion of the night, that is to say before midnight, then the shadow of the earth covering them little by little would darken them from the top downwards. On the other hand, if they were first seen after midnight, then it was the upper edge that lighted up first, the cloud rising out of the shadow.

The "Earth's Shadow" came strongly into evidence in the case of the Krakatoa "afterglows." The Rev. S. E. Bishop, writing to *Nature*, Vol. XXIX., p. 549, says:—

> "I beg special attention to my former remark of the 'earth-shadow sharply cutting off' the upper rim of the first glow. This was very manifest in the strong heavy glows of September, showing clearly that the first glow directly reflected the sun's rays, while in the afterglow, which had no defined upper rim but continued much longer, the haze reflects only the light of the first glow."

And, again, in *Nature*, Vol. XXX., p. 194, he writes:—

> "In your issue of April 10th (p. 549), is the statement by an observer in Australia that the 'red glow was margined by an immense black bow stretching across from the north-west to south-east.'
>
> "I wish to say that the above language almost exactly describes the appearance to which I alluded on the same page as 'the earth-shadow cutting off the upper rim of the glow.' The 'black bow' of the Australian was evidently the shadow of the horizon projected on the haze stratum. In both the above cases the lower surface of the haze was evidently well defined, so that, as the horizon intercepted the direct rays of the sun, a well-marked shadow moved westward and downward. Above this black rim or bow appeared the secondary glow, produced by the reflection of the sun's rays from that portion of the haze surface which was directly illuminated. Very often the second glow was more conspicuous and impressive than the first, because it shone against the dark sky of night."

If the secondary glow were due to the reflection of direct sunlight, then no doubt its upper edge would have been sharply marked off by the earth's shadow, just as was the case with the primary glow. But its diffusion as compared with the definiteness of the earlier glow points to its being a reflection of the latter, a view strengthened by the fact that the depression of the sun below the horizon at the sinking of the second glow was as nearly as could be determined double what it was at the sinking of the first.

Prof. A. Riccò, in addition to these two points, mentions a third. From time to time in fine weather the phenomenon is presented at sunset of "Crepuscular Rays." These are broad pink ribands of light diverging like the

* Gerard Hopkins: *Nature*, January 3rd, 1884, p. 223.

sticks of a fan from the point where the sun has just gone down. They are formed in a very similar manner to the rays of light which we sometimes see in moisture-laden air, when the sun itself is hidden behind a dense cloud, and which children are accustomed to speak of as "the sun drinking." In the latter case, these bands of light are due to the sun shining out from between irregularities of the clouds and lighting up the laden air, which shines in the path of the rays just as the particles of dust do—"the motes in a sunbeam"—when light is admitted through a small aperture into a darkened room. In the case of the crepuscular rays, mountain ridges or banks of cloud may serve to partially intercept from the upper atmosphere the light of the sun which has set, throwing their shadows in long lines upwards, whilst the sunset glow shines out in the intervals between the clouds or in the depressions between the mountain peaks, and is seen by us as a radiating system of broad pink streamers. Here in England it is rare that these streamers can be traced very far towards the zenith; they are usually lost as they pass overhead, though sometimes their termination may be seen as counter rays in the east. Col. E. E. Markwick,* however, records that he has seen the rays in South Africa night after night extending from horizon to horizon; the radiation from the west and convergence again towards the east being, of course, an effect of perspective. In the case of the Krakatoa sunsets, Prof. Riccò remarked on several occasions these crepuscular rays as being conspicuous in the primary glow, but they were not seen in the secondary, a further proof that the former was due to direct, and the latter to reflected sunlight.

If we look across water towards the setting sun, we see a broad track of light extending from below the sun's place towards us, due to the reflection of the sun from the surface of the waves. It occasionally happens that an analogous reflection is produced in the air from the under surface of ice-films floating horizontally. In this case a vertical shaft of light is produced, rising from the sun as a base, which is known as a "Sun-Pillar," and of which a very fine example was seen on March 6th, 1902, over the greater part of southern England. The difference between the formation of such a sun-pillar and the Krakatoa afterglows depends partly upon the greater elevation of the stratum giving rise to the glows, and partly because of the smaller size of the particles forming it. The ordinary atmospheric particles are very small compared with the wave-length of light, and hence scatter especially the shorter rays, those producing the sensation of blue. The particles of the Krakatoa dust were large in comparison with these, and hence scattered rather the rays of long wave-length—the red rays. The composite effect of the glows therefore resulted from the interaction of these two different orders of particles upon the rays passing through them. And over and above the richer and more complicated sunset colours that were thus produced, there was the reflection of the sunset glow itself by a stratum of highly reflective dust particles at a great elevation.

"Thus we may probably conclude that the haze which followed the eruption of Krakatoa, and produced the twilight glows, was composed mainly of very fine dust, and that this dust at a great altitude reflected the light of the setting or rising sun after diffraction through the stratum and diffraction and absorption by the lower atmosphere, and secondarily again reflected this reflected light."†

The heavens are the province of the astronomer, the atmosphere of the meteorologist, and all the various phenomena that have been referred to above belong to the atmosphere, and hence meteorology may be said to have a claim upon them. But they are distinguished from purely meteorological objects—such as the various orders of clouds, rainbows, haloes, parhelia and the like—in that they are connected directly with the earth's rotation, and with its position relatively to the sun. They are phenomena of the earth as a planet rather than of the earth considered as a world complete in itself, and from this point of view may be considered as belonging to astronomy. But they are referred to here, not so much on this account as from the illustration they afford of the value of the habit of exact observation. "Science," it has been often said, "is measurement"; it certainly depends upon the record of phenomena in numerical form. The difference in value is immense between the most vivid and picturesque description of a flight of a meteor and the half-dozen numbers which give the time of its appearance, its brightness, and duration, and the precise position of its path. It is only the latter which are of permanent value, and it is only from the habit of registering the obvious facts connected with a given phenomenon that the faculty is developed of recognizing other points needing numerical expression and record. Thus in the case of the beautiful sun-pillar of March 6th, 1902, though many vivid descriptions were written of it, so far as I know only one observer noted what should have been apparent to all, namely that the pillar moved an appreciable distance in azimuth, following the unseen sun in its northward movement below the horizon. So in the case of the afterglows it was only those observers who had made specific observations of ordinary sunsets, and who knew accurately their characteristic features, who could state definitely and with precision that the sunsets after Krakatoa were abnormal, and define wherein their peculiarities consisted. Striking as they were, it was by no means everyone who saw anything in them out of the common, and even so experienced an artist as the late Mr. John Brett, F.R.A.S., failed to recognise wherein they differed from an ordinary sunset, or indeed that they differed from it at all. Then when their abnormal character was recognised, the careful timing of the sinking below the horizon of the primary and secondary glows was of the first importance as giving the means for computing the height of the reflecting stratum. In the case of the appearance of such glows on future occasions, or of the crepuscular rays, or of a sun-pillar, it is very desirable that not only a precise note of the times of the phenomenon should be taken, but that also the angular extent of the various rays should not be merely roughly estimated but actually measured. A long, light, but stiff rod carrying a sliding cross-piece—a sort of tangent staff, in fact, not unlike that used by Chandresakhara—would be of much service in determining the height and breadth of a sun-pillar, the angle which a crepuscular beam made with the horizon, the height of the brightest part of an afterglow, and so on. Such an instrument might, indeed, seem rough, but its accuracy and precision would be found to be beyond comparison greater than that of mere estimation.

* Knowledge, 1901, April, p. 88.

† Hon. Rollo Russell: "The Eruption of Krakatoa," p. 195.

THE ECLIPSE OF THE MOON, OCTOBER 17 AND HOW TO PROJECT IT.

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

From few problems in astronomy can such satisfaction be derived as that of the projection of a lunar eclipse. Moreover, it is so simple that few need fear to attempt it, and thereby be able to delineate the phase of an eclipse at any moment, whilst it is instructive in that actual use is made of terms which are frequently no more than definitions.

Just before sunrise on the morning of the 17th the moon is totally eclipsed, and although the following method is applicable to any lunar eclipse, we will deal more particularly with the one of this date. An eclipse of the moon takes place when the moon plunges into the earth's shadow, and thus is deprived of the sun's rays. If then we can ascertain the size of the shadow at the point where the moon is situated, and also know the direction and rate of movement of the moon through it, we have the material for predicting any particular phase of the eclipse.

From the *Nautical Almanac* we have given—

Moon's equatorial horizontal parallax	= 59′ 13″	=	3553″
Sun's " "	= 9″	=	9″
Sun's radius	= 16′ 3″	=	963″

Adding the two former, and from the sum subtracting the latter, we get 2599″, which represents the radius of the earth's shadow at the point of the moon's orbit.*

The earth's atmosphere, however, tends to increase the size of the shadow, and on this account it is usual to increase the above radius by about $\frac{1}{50}$th; we will therefore take—

Radius of shadow = 2650″.

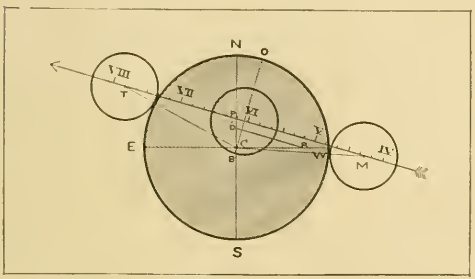


Diagram showing path of moon through earth's shadow.

Take a convenient scale of equal parts (say $\frac{1}{100}$ inch = 10″), and with C as centre and radius C W equal to 2·65 in., describe the circle N E S W representing the earth's shadow.

The declination of the centre of the shadow C will be the same as that of the sun but of contrary sign, thus since the declination of the sun is south, that of the

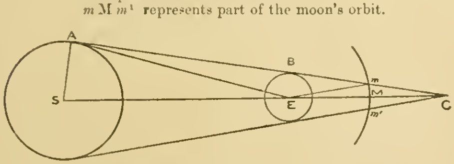
Shadow = N 8° 55′ 21″,

whilst the Moon's declination = N 9° 8′ 53″

make C P = 13′ 32″ = 812″,

* Apparent semi-diameter of the earth's shadow at the moon; that this is the algebraic sum of the above quantities is shown as follows:—

S represents the sun.
E represents the earth.
m M m^1 represents part of the moon's orbit.



Semi-diameter of earth's shadow at moon = m E M.

m E M = E m A − E C m.
= E m A − (A E S − E A C).
= E m B + E A B − A E S.
But E m B = Moon's horizontal parallax.
E A B = Sun's horizontal parallax.
A E S = Sun's apparent semi-diameter.

which is the amount the moon is north of the centre of the shadow; also make

C D = 9′ 11″ = 551″,

which is the hourly motion of the moon from the shadow in declination, and since the direction of this motion is northwards, the point D is taken north of the centre C; also make C R equal to the hourly motion of the moon from the sun in right ascension, this is 32′ 14″·7, which, to be represented on the line C W must be reduced to the arc of a small circle by multiplying by the cosine of the declination, thus:— 32′ 14″·7 × cos. 9° 9′

= 1934·7 × 0·9875

∴ C R = 1910″.

Join R D; then by the parallelogram of velocities this represents the direction and hourly rate of the moon's motion.

Through P draw M T parallel to R D; it is evident then that M T represents the path of the moon through the shadow. P is the position of the moon's centre at the time of opposition = 6h. 10m. 13·1s., and since R D represents the motion in one hour, a proportional part, P VI., can be taken equal to the motion in 10m. 13·1s., then VI will be the position of the moon at six o'clock. Make the distance from VI. to V., and from VI. to VII., &c., equal to R D, and we have a time scale which may be sub-divided, and from which the time of any phase may be derived.

The moon may now be drawn in at any required position, such as the first contact at M, by taking the radius of the circle to be described equal to the moon's semi-diameter. In this case,

Moon's semi-diameter = 16′ 8″·4,

or the points of first and last contact, M and T, may be found by making C M or C T equal to the sum of the semi-diameters of the shadow and moon.

The magnitude of the eclipse is measured by the ratio of the amount the innermost limb of the moon is obscured O B to the moon's diameter.

Elements.

Eclipse of Moon, October 17th, 1902.

Greenwich mean time of opposition in R.A.,	H.	M.	S.
October 16th	18	10	13·1
	°	′	″
☾'s Declination	N. 9	8	52·8
☉'s Declination	S. 8	55	20·5
☾'s Hourly motion in R.A. .. .		34	34·7
☉'s Hourly motion in R.A.		2	20·0
☾'s Hourly motion in declination	N.	10	6·4
☉'s Hourly motion in declination .	S.		55·2
☾'s Equatorial horizontal parallax		59	13·20
☉'s Equatorial horizontal parallax .			8·84
☾'s True semi-diameter		16	8·37
☉'s True semi-diameter		16	3·15

Magnitude of Eclipse (Moon's diameter = 1) 1·463.

Obituary.

RUDOLPH VIRCHOW.

By Sir Samuel Wilks, M.D., LL.D., F.R.S.

The death of Professor Virchow has removed from the world of science one of its most devoted followers, and from the medical profession one who held the most eminent place in its ranks. Wherever scientific medicine was recognized the name of Virchow was as familiar as a household word. Pathology has as broad a basis as humanity itself, and so has united its cultivators in all parts of the world under one common master.

Nothing less than a volume could contain all the details of the life of this great man, as he was not only closely allied to the scientific world, but he held an important place in politics, possessing a seat in the Prussian Diet, as well as being a member of the Municipal Council which imposed upon him important hygienic work. At the present time, therefore, we can only regard the scientific aspect of the man, and even this presents too large a view to allow me to do more than speak of him from a personal acquaintance which I enjoyed nearly forty years. Virchow was a Pomeranian, and was born at Schivelbein on October 13th, 1821. He distinguished himself at a local school and then proceeded to Berlin to study medicine. He joined an Institute connected with the University and obtained his practical knowledge at the Charité Hospital. He took his degree in 1843 and soon afterwards became an external lecturer on Pathology. At this time he was deputed to investigate an

Medallion cast in honour of Prof. Virchow on the occasion of his 70th birthday.

epidemic of fever, and his report so strongly reflected on the sanitary condition of the neighbourhood that it attracted much attention and criticism. His name also became associated with the Radical Party in Parliament, and thus he came into collision with the "man of Blood and Iron," and with other government officials. All this made his position as a teacher in the University very uncomfortable, and this being apparent, he was invited to accept the Professorship of Pathology at the University of Wurzbürg. This he did, and took advantage of the opportunity to devote himself entirely to the duties of his Chair. He made some very remarkable contributions to subjects connected with his work, which gave him at once a very prominent place amongst the scientific men of the day. His work was so carefully done, and his observations made with such perfect accuracy, that he was able to put forth his principles with the greatest confidence, and these being translated into different languages were seen to be the utterances of a master mind, and were at once accepted as the embodiment of truth.

His fame became so great that Berlin was only too ready to call him back, and the University to offer him the Chair of Pathology. This was in 1856, after a residence of five years at Wurzbürg. It was not long before he issued his great work, which made his name famous throughout the scientific world. This was the celebrated "Cellular Pathology." Its purport was to show how the cell was the unit of life, and that all growth proceeded from pre-existing cells. This was a substantial basis; a new and solid foundation, not only to explain morbid processes but healthy and physiological ones. The doctrine which was held at that time originated with Schwann, who, with the elaboration of the microscope, did much original work with respect to the ultimate tissues, both of the animal and vegetable kingdom. He taught that a fluid was thrown out from the blood, which he called the blastema; in this fluid a number of granules sprung up, which after a time formed themselves into groups or nuclei, and around these again the cell was formed. All cell life was thus produced in this cytoblastema. Virchow, by an unwearied study of years, completely upset this theory, and showed how every cell sprung from a pre-existing one. The cells afterwards became modified and altered to their respective forms, but in all cases they originated from parent cells. Just as the animal or plant is produced from one of a like kind, so do the individual cells composing them have a similar parentage. This was his great doctrine which was found to be true throughout the whole of living nature, and lies at the basis of all the laws of heredity. It was formulated by him into the sentence, "*Omnis cellula a cellulâ.*" This was an epoch-making doctrine, and will take its stand by Harvey's "Circulation of the Blood," Newton's "Law of Gravitation," or Darwin's "Origin of Species."

Besides the great work of Virchow, there are to be found in his "Archives," which he edited since the year 1847, numerous papers of great merit and originality. I may mention that of "embolism," the name he gave or adapted to the case where fibrinous matter is carried with the blood through the vessels until it blocks one of the smaller ones, as, for instance, an artery leading to the brain, when it leads to softening and paralysis. I might mention also his article on ulceration of bone, characteristic of a well-known specific disease. Virchow had a typical scientific mind, so that he said nothing that was not found to be absolutely correct and true—for example, in his work on tumours he refers to his examination of specimens in our English museums, and as regards that at Guy's, I found that he had appended the number which was written on the label to each example mentioned. Like Faraday, Darwin, and others of that stamp, he possessed in the highest degree a simple honesty of purpose. As showing his truly scientific turn of mind, I might quote his answer to those persons who wished him to investigate the miraculous case of a girl who had, every Friday, the bleeding stigmata appear upon her body. He said: "Every miracle exhibits a tendency which natural science does not. The miracle is produced with a determinate aim, seeks notoriety, stimulates attention, and advances to meet all mankind. Nature's laws are retiring, they have no interest in man, it being man who has an interest in the laws."

It may be mentioned that Virchow interested himself in everything appertainiog to anthropology; and so he was enthusiastic in Schliemann's work in the Troad, and in 1882 he wrote a paper on old Trojan graves, and gave a description of the skulls found therein. It should be mentioned, too, that Virchow received from the Royal Society in 1893 the Copley medal, the highest honour it could bestow. France made him Commander of the "Legion of Honour," and he received distinctions from other countries, but no honour could add lustre to his name.

On reaching his 70th birthday a very remarkable ovation took place at Berlin to celebrate the occasion, and a medal was struck in his honour, and copies were made in gold, silver, and other metals. It had a diameter of 180 millimetres (7 inches), and the gold one weighed 2·3 kilograms (5 lbs.). On one side is a bust of Virchow surrounded by the inscription "*Rudolphus Virchow Pomeranus Civis Berolinensis. Ætat LXX.*" On the reverse is seen a female figure seated, representing anatomy, one hand resting on a book in her lap, and the other holding a skull. Science is represented by a male figure with wings holding a flaming torch over her head. In the background is the figure of Diana, a mummy, a skull, a microscope, a jar labelled "*embolia,*" and other emblems of the arts and sciences. Written below are the words "*Omnis cellula a cellulâ.*"

The celebration of his 80th birthday took place on October 3rd of last year, when representatives of all nationalities crowded to do him honour at Berlin. It resembled no state ceremony, but was a spontaneous burst of homage from the civilized world. Lord Lister spoke on behalf of Great Britain, and said, that they joined in recognition of his gigantic intellectual powers and in the gratitude for the great benefits that he had conferred upon humanity, and in admiration of his personal character which was marked by absolute uprightness. Various places of learning sent him their congratulations.

Few men had so world-wide a reputation as Virchow, and therefore, everyone in England was glad to meet him, especially those who regarded him as their great teacher. He paid many visits to this country, and being a good scholar, made his speeches in English, but with considerable foreign accent. One of his most notable visits was at the time of the International Medical Congress in 1884. He joined with Sir James Paget, Huxley, and others, in giving addresses at St. James' Hall. He spoke on the value of experiments on animals, and concluded by asking the opinion of the company present on the question; the response as to their utility was carried without a dissentient voice.

Another very remarkable occasion was his visit to Edinburgh on the occasion of the tercentenary of the University, when its degree was conferred upon him. Some of the most learned men in Europe were there, but no one was more distinguished than Virchow.

On March 10th, 1893, Virchow was invited to give the Croonian Lecture before the Royal Society. The large room of the University of London was crowded to hear him deliver it; the subject being "The place of Pathology in Biological Study." In the evening a dinner was given to his honour at the Whitehall Rooms, Lord Kelvin being in the chair, and Sir James Paget and other eminent men made speeches to his honour.

On October 3rd, 1898, Virchow was invited to give the Huxley Lecture at Charing Cross Hospital. This was founded in honour of Huxley, who was educated there. The subject was "Recent advances in science, especially those bearing on Medicine and Surgery." This he delivered to a crowded audience at the neighbouring St. Martin's Hall. In the evening a dinner was given to him, presided over by Lord Lister. Being president of the College of Physicians, I was enabled to state the indebtedness of the profession to Dr. Chance for his admirable translation of the "Cellular Pathology," which brought this great work so soon before the profession in England.

On January 3rd of the present year he broke the neck of his thigh bone in alighting from a car. He soon recovered from the shock and went into the country, where his health much improved, although he did not expect to have the use of his leg again, for on examination by the Röntgen rays, he declared that no union could take place. Afterwards his strength began to fail, and he passed away on September 7th.

His remains were brought to Berlin and placed in the Rathaus, where they lay in state. On September 9th the funeral took place, a service was held, and the coffin then carried to the cemetery of St. Mathew's Church, followed by a procession a mile long. Besides the representatives of the University, many statesmen were present. Prof. Waldeyer delivered an oration on the part of science, and others followed in their different capacities.

A writer has said of Virchow, that he was the great pioneer of the obscurest of sciences, yet crossed swords with the chief of a political party, and also accomplished more social and administrative reform than any other man of his time; another writer that he was absolutely simple and devoid of self-consciousness, sincere, kindly, and unassuming; he was absorbed in his subject, the embodiment of accurate knowledge and sound judgment, the truest servant of truth.

British Ornithological Notes.

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

Black-eared Wheatear in Sussex.—A new species for the British list. At the meeting of the British Ornithologists' Club, held on June 18th last, Mr. W. Ruskin Butterfield exhibited a male specimen of this Wheatear or Chat, which had been shot near Polegate, Sussex, by a man named Williams on May 28th, 1902. Mr. Butterfield follows Mr. J. I. Whitaker in calling the bird *Saxicola caterinæ*, a name given to the western form of *Saxicola aurita*—the Black-eared Wheatear. It is at all events the western form of the bird which has now been recorded for the first time as having visited us. This form of the handsome and brightly coloured Black-eared Wheatear seems restricted to the South of Spain, North-west Africa, and Sicily, while the eastern form of the bird is found throughout the greater part of the South of Europe, Asia Minor, and North-east Africa. We are afraid that the present example is only a straggler, and we cannot expect this lovely species to make a habit of paying visits to these inhospitable shores.

The Starling as Foster Parent.—The somewhat singular incident of the Starling performing the duties of foster parent has been witnessed here; a female bird steadily feeding two young Song Thrushes, which follow her about most closely. The foster parent's duties are very carefully and studiously carried out.—W. Dunn, Withycomb, Exmouth.

Grey Lag-goose in Ireland.—A specimen of the south-eastern form (*Anser rubrirostris*) of the Grey Lag-goose was exhibited by Mr. F. Coburn at the June meeting of the British Ornithologists' Club. The bird was one of five received by the exhibitor from Limerick on November 23rd, 1901. One of the characters pointed out by Mr. Coburn as separating this bird from the Grey Lag familiar to English sportsmen was its longer and more slender body.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at the Office of* Knowledge, 326, *High Holborn, London.*

Notices of Books.

"Metallography: an Introduction to the Study of Metals, chiefly by the Aid of the Microscope." By Arthur H. Hiorns. (Macmillan.) 6s.—This book discloses the progressive nature of the study of metal structure by means of the microscope, and is the first complete handbook which has appeared on the subject. Articles by practical workers have constantly appeared in the various scientific journals, and there is actually a quarterly publication emanating from America which deals solely with this subject, but the volume before us gives in short but precise terms, not only the state of knowledge at the present time, but the methods of obtaining that knowledge. It cannot well be said that sufficient data and knowledge have been gained to class micro-metallography as an exact science, but such information as has already been obtained, has been of the most invaluable description, and this book will enable those who may be beginning, to start at the point at which advanced workers have arrived, and make those who are working in a more or less isolated manner, acquainted with the latest methods. The purpose of the microscopical examination of metals is admirably given in the writer's own words:—"It must be clearly recognised at the outset that microscopic examination is not intended, nor ever will replace chemical analysis or mechanical testing of metals. Its function is to add additional information of a kind which other methods are incapable of yielding. Thus, in steel, ordinary chemical analysis will indicate the total quantity of carbon, combined and free, but will not reveal the presence of definite mineral constituents, such as ferrite, cementite, pearlite, martensite, and the manner in which they are associated in the steel." Seeing that the whole study is dependent on the microscope being suitable for the work, it is somewhat singular that so small an amount of information regarding this instrument should be given. No real direction is provided to guide the beginner in his selection. Is, or is not, the raising and lowering of the stage by rackwork desirable? Should the objectives have large or small apertures, and have the apochromats proved more effective than the ordinary achromatics? Again, ought not the objective to be constructed specially to work on subjects having no cover glasses? These are points which one would expect to have elucidated, but the situation is summed up by the writer so far as the microscope stand is concerned, by the words, "the instrument should have a firm and fairly heavy stand . . . . . a mechanical stage is quite unnecessary." The instructions for photographing, and the illustrations, which are numerous, although they have evidently lost detail in the reproduction, are exceedingly instructive and interesting.

"Injurious and Useful Insects." By L. C. Miall, F.R.S. (Bell & Sons.) 3s. 6d.—All teachers of economic zoology must feel grateful to Prof. Miall for this excellent little book, from which a student can hardly fail to learn how to observe, think, and act for himself. It opens with an account of the Cockroach as a typical insect. Then come full descriptions of some thirty selected common insects of various orders, attention being given to their form, life-history, bionomics, and practical importance, as useful or harmful to the farmer or gardener. This section occupies the greater part of the book, and is followed by a short summary of the insect orders and their more important families. Finally, the author gives a section on the "Destruction or Mitigation of Insect Pests," placing before the student some general principles to guide him in his economic work and relating in detail the successful struggles of American entomologists against the "Gipsy Moth" and the "Fluted Scale." The style of the book is beautifully clear, and the facts are set forth so as to attract and fascinate the student. He is led to study an insect practically, and encouraged to look for the reasons of what he observes. The accounts of the life-histories are constantly lighted up with bright flashes of suggestion. "Why," asks the author, "has the female Vapourer Moth no wings?" He points out that first of all we need to ask, "Why insects fly at all"; and thus we are led on to a fruitful discussion of the relative importance of the larval and perfect stages in securing the spread of an insect species. Everywhere is pressed home the lesson that the successful mitigation of insect pests depends upon our knowledge of their life relations. The book cannot fail—in the full sense of the words—to educate naturalists.

In answer to many enquiries, the publishers of Knowledge state that Mr. E. W. Maunder's book, "Astronomy without a Telescope" (which also contains the articles on "Constellation Studies") will be ready about the middle of October. A large portion of the work has been rewritten.

BOOKS RECEIVED.

Elements of the Theory of the Newtonian Potential Function. By B. O. Peirce, PH.D. (Boston and London: Ginn & Co.) 12s.

Beasts of the Field. By William J. Long. (Ginn & Co.) Illustrated. 7s. 6d.

Fowls of the Air. By William J. Long. (Ginn & Co.) Illustrated. 7s. 6d.

The Common Spiders of the United States. By James H. Emerton. (Ginn & Co.) 6s. 6d.

Our Country's Fishes and How to Know them. By W. J. Gordon. (Simpkins.) Illustrated. 6s.

Zoological Results based on Material from New Britain, New Guinea, &c. By Arthur Willey, D.SC., F.R.S. Part VI. (Cambridge University Press.) Illustrated.

A Popular History of Astronomy during the Nineteenth Century. By Agnes M. Clerke. 4th Edition. Revised and corrected. (A. & C. Black.) Illustrated. 15s.

The Foundations of Geometry. By David Hilbert, PH.D. Translated by E. J. Townsend, PH.D. (Kegan Paul.) 4s. 6d.

On the Distribution of Rain over the British Isles during the Year 1901. Compiled by H. Sowerby Wallis and Hugh Robert Mill, D.SC., LL.D. (Stanford.) 10s.

Electrical Installations. By Rankin Kennedy, C.E. Vol. II. (Caxton Publishing Co.)

Induction Coils for Amateurs. Edited by Percival Marshall. (Dawbarn & Ward.) Illustrated. 6d.

P. O. P. By A. Horsley Hinton. (Hazell.) Illustrated. 1s.

The Journal of the Anthropological Institute of Great Britain and Ireland. Vol. XXXII. Published by the Institute. 10s.

Proceedings and Transactions of the Meteorological Society of Mauritius. Vol. II.

NOTES.

Astronomical.—Six spectroscopic binaries, in addition to the thirty-two previously announced, have lately been discovered at the Lick Observatory, namely, ϕ Persei, η Geminorum, γ Canis Minoris, ζ Herculis, α Equulei, and o Andromedæ. Including three stars of this class detected by Belopolsky, Prof. Campbell points out that out of 350 stars observed, one in eight is a spectroscopic binary, while many others are suspected. He also expresses the opinion that as the accuracy of measurement becomes greater, the star which is not a spectroscopic binary will prove to be the rare exception. The instruments for continuing the work in the southern hemisphere have been completed, and it is hoped that the expedition may be able to sail in the near future for Valparaiso, to occupy a station near Santiago, Chili. Mr. D. O. Mills has again shown his appreciation of the work of the Lick Observatory by a gift of a thousand dollars for improvements of the Mills spectrograph, and Mrs. Hearst has presented a sum of 2500 dollars to increase the equipment of the Observatory. It is announced that copies of any of the photographs taken at the Observatory may now be obtained at moderate expense on application to the Director.

The discussion of the connection between the variations of terrestrial magnetism and solar activity has chiefly been confined to comparisons of magnetic phenomena with sunspots, and it is well known that while the diurnal range corresponds closely with the sunspot cycle, a difficulty has arisen from the fact that a great sunspot may or may not be accompanied by a magnetic storm. Sir Norman Lockyer has recently investigated the magnetic variations in relation to the observations of the chromosphere and prominences made by the Italian observers during the last thirty years, and has concluded that the epochs of great magnetic storms correspond with those of the greatest disturbances of the chromosphere near the sun's poles, while the general magnetic curve agrees closely with that of prominences observed near the solar equator.—A. F.

Botanical.—*Torreya* for August contains, in a note by Dr. M. A. Howe, some interesting information on the vitality of the spores of *Marsilia*. Prof. D. H. Campbell proved several years ago that the spores of *M. ægyptiaca* may germinate when twelve years old. Some spores which he obtained from dried specimens preserved for that period in the Berlin Botanical Museum germinated within thirteen hours after being placed in water. He found that in the case of spores eleven years old fifty per cent. germinated, and of those five years old nearly all grew. According to Prof. Barnes, spores of *Marsilia quadrifolia* retained their vitality after being kept for three years in commercial alcohol. Dr. Howe has experimented with spores procured from material which had lain in the herbarium for periods varying from twelve to thirty years. The oldest spores which grew were practically eighteen years old, and belonged to *M. vestita*. Nearly all the megaspores formed prothalli with archegonia, and practically all the microspores reached an advanced stage of germination, though only about half set free motile spermatozoids. The first of these were seen in eleven and a quarter hours after the sporocarps were placed in water.—S. A. S.

Entomological.—A Centipede of quite exceptional interest has been described (*Quart. Journ. Micr. Sci.*, Vol. XLV., 1902, pp. 417-448) by Mr. R. I. Pocock. It was discovered on the summit of Mount Romney, Hobart, Tasmania, and it "proves to be comparable in interest to either of its compatriots Ceratodus or Ornithorrhynchus, as it unmistakably represents an archaic type which has survived in this isolated corner of the world." The species (*Craterostigmus tasmaniensis* by name) possesses fifteen pairs of legs, like our own well-known Lithobii, but it differs from all other known centipedes in having more tergites than sternites in its skeleton. There are fifteen of the latter, corresponding with the pairs of legs, but twenty-one of the former. Now, as the large tropical centipedes—Scolopendra and allies—have twenty-one (or twenty-three) leg-bearing segments, Mr. Pocock concludes that this Tasmanian form represents a connecting-link between the Scolopendrids and the Lithobiids, six sternites, with their accompanying pairs of legs, having vanished, but the tergites still remaining. We get thus a most suggestive clue to the method of evolution among the centipedes.

An account of the life-history of the beetle *Clythra quadripunctata* is given by Mr. H. St. J. K. Donisthorpe (*Trans. Ent. Soc. Lond.*, 1902, pp 11-25). The female beetle drops her eggs on the ground near nests of the Wood Ant (*Formica rufa*), and as the eggs are enclosed in cases formed of the mother's excrement, which give them the appearance of small bracts, the ants carry them into their nests. The grubs feed on vegetable substances contained in the nest, protecting themselves by building up hard, insoluble cases of excrement. When a beetle emerges from the case at the end of the pupal stage, it creeps stealthily out of the nest, stopping and "feigning death" if approached by the ants, which seem to behave in an unfriendly way to this "guest" both in the larval and perfect states.—G.H.C.

Zoological.—Professor Ray Lankester's long-expected memoir on the okapi of the Semliki Forest has been issued in the *Transactions* of the Zoological Society, forming the sixth part of Vol. XVI. It is illustrated by a coloured plate drawn from the presumably immature specimen in the British Museum, and numerous text figures of skulls, etc. Fortunately, the Belgian specimens, which prove the occurrence of horns in the okapi, arrived in this country in time to receive a brief notice in Prof. Lankester's memoir. The probable affinities of the animal are discussed in considerable detail by the author. It may be well to notice that in the fourth line from the bottom of page 287 the word *incisor* should be *canine.*

To the *Proceedings* of the Royal Society (Vol. LXX., No. 465) Messrs Alcock and Rogers communicate an interesting paper showing that the saliva of many reputedly harmless Indian snakes has poisonous effects when injected into the blood of small mammals. And they are enabled to indicate a gradation, so far as toxic properties are concerned, from species like the rat-snake, in which the teeth are solid cones, through other kinds with teeth channelled behind, to the deadly cobra and its kindred, in which the fangs have assumed the form of hollow cones for the conveyance of the venom from its receptacles.

Dr. R. Lehmann-Nitsche, of the La Plata Museum, has recently published in the German *Archiv für Anthropologie* (Vol. XXVII., Art. 19) the evidence for regarding the extinct Patagonian ground-sloth, of which the skin and other remains were discovered a few years ago in a cavern at Last Hope Inlet, as a contemporary of the ancient cave-dwellers of the country, by whom indeed these animals appear to have been domesticated.

With the exception of a few elephants' teeth and bones, vertebrate remains appear to have been hitherto unrecorded from Japan. The appearance of a memoir in the *Journal* of the Tokio College on a fossil Japanese mammal of presumably Miocene age is, therefore, a matter of considerable interest, more especially as the remains appear to indicate a form quite unlike any known from other parts of the world. The authors of the memoir regard the fossil as referable to the elephant group, but it is quite likely that this determination may be called in question.

Dr. J. Wortman has been re-examining the magnificent series of American Eocene carnivora collected by the late Prof. Marsh, and has published the results of his investigations in the *American Journal of Science.* He is of opinion that the primitive mammals known as creodonts should be included among the carnivora, and also that they are closely related to the marsupials. But he refuses to accept the modern view that marsupials themselves are the descendants of placentals; and inclines to the opinion that both creodonts and modern marsupials are derived from a non-placental stock. How, on this view, we are to explain the occurrence of a vestigial placenta in the bandicoots, the author does not say.

In a memoir issued by the Survey Department at Cairo, Messrs. Andrews and Beadnell give a preliminary description of new forms of extinct mammals from the Fayum district of Egypt. Perhaps the most remarkable is an imperfect lower jaw furnished with a pair of serrated and recumbent incisor teeth, which they regard as probably representing a new type of carnivora, and name *Phiomia serridens.* To the same is provisionally assigned the front part of an upper jaw with a single pair of large tusk-like incisors. Very interesting is part of an upper jaw described as *Saghatherium antiquum*, which seems to indicate the oldest representative of the hyrax group at present known. Another mammal from the same deposits is assigned to the widely-spread Tertiary genus *Ancodus*—one of the transitional forms between pigs and ruminants. The authors are now of opinion that the beds containing remains of the genus last mentioned, together with *Arsinotherium*, *Palæomastodon*, etc., are of Upper Eocene age, while the underlying deposits with *Mœritherium*, *Bahytherium*, etc., are Middle Eocene. Below these come other beds from which have been obtained remains of the primitive cetacean *Zeuglodon.*

THE BIOGRAPHY OF A SNOWFLAKE.

By Arthur H. Bell.

It is one of the most interesting things in connection with the subject of the weather that all its phenomena are so closely in touch with one another, and that in order to explain any one of them it is necessary to take account of all the rest. A further fact is that the various phenomena have a power of transforming themselves very quickly as it were into something else, so that it is often a long process to hunt down and discover what is the fundamental structure of these fugitive shapes. A snowflake, for instance, at first sight might be thought to have a separate existence from any of the other children born of aqueous vapour, but on attempting to follow up the history of these "frozen flowers," as Professor Tyndall called them, it is found that the attention is at once directed to the consideration of such things as rain, hail, sleet, mist, dew, hoar-frost, and clouds. Hail, rain, sleet and snow are, of course, very nearly related indeed, but similarly to the other phenomena they are all built up out of aqueous vapour, and when vapour is condensing out of the atmosphere it is, at some seasons of the year, quite as likely to take one shape as another. Of the phenomena mentioned above hail is probably the most noisy in its descent from the atmosphere to the earth, and this more especially when it happens to be accompanied by a thunderstorm. On the other hand hoar-frost and snow are probably the quietest of all the children of the air, while as regards their picturesque effects, who would venture to decide between two such skilful artists? Snow, which is the parent of the grinding glacier and the stupendous iceberg, has, however, such notable effects on climate and on weather that few meteorological phenomena can compare with it for interest.

Now it is probable that, as is the case with a raindrop, or with hail, in order to give a snowflake a start in life there must be a tiny nucleus of dust, round which the condensing vapour may gather. It is mainly a question of temperature as to what form this condensing moisture will take, but commonly when the temperature is above the freezing point rain is the outcome. When this process takes place in a body of air at or about the freezing point, snow gets its opportunity; while when the condensed moisture does not at once freeze solid, hail will be more likely to occur. At some times, indeed, both snow and hail take the form of little fluffy pellets of frozen moisture, and considerable experience is necessary to distinguish between them. As a general rule, the colder the weather the smaller the snowflakes; the large flakes, which children describe as being due to the old woman plucking her geese, appearing when the thermometer is not far away from the freezing point. Large flakes, indeed, are a conglomeration of smaller flakes, and it is in the latter that the greatest regularity and beauty of structure are to be seen.

In order therefore that a snowflake may make a successful journey through the atmosphere it should be built up on a particle of dust, while if it should be fortunate enough to commence its career at the top of a cloud soaring many miles above the level of the earth, it will thereby become still better equipped for adding to its stores of frozen vapour. Between the growing snowflake and the earth, it should be borne in mind, there are in ordinary conditions strata of atmosphere that differ very much as regards their temperature, and the amount of moisture they contain. These different layers through which the descending snowflake will pass favour its development, for it often happens that in one layer of atmosphere the flake gathers moisture which is promptly frozen in the succeeding layer. In this connection it is well to recall what happens when one holds a snowball, or two pieces of melting ice in a warm hand for any length of time, for either can be welded into a solid lump by a little pressure, a process commonly called regelation, and to be borne in mind when seeking for the causes that favour the growth of a snowflake.

From each layer of atmosphere through which it passes the fluttering snowflake may therefore be thought of as collecting a tribute of moisture, but unlike a hailstone it makes these accretions in gentle fashion. There is a fuss and a dash with the downward plunge of a hailstone, so that the frozen moisture is welded around it with great force and it quickly grows hard and solid. On the other hand, with a snowflake the frozen moisture is not so much welded as it is enmeshed, for on every snowflake, even in its early moments, there are protuberances and spicules that catch the floating moisture as in a tiny net. The most common forms of snowflake have a solid nucleus with rays ramified in different planes, others taking the shape of six-sided needles or prisms, or six-sided pyramids. A complicated snowflake takes the form of a six-sided prism from one or both ends of which six-sided plates are projected. Another kind of snowflake is found to be simply a thin lamina of frozen moisture, snowflakes of this class being observed in great variety. Many interesting sketches have been made of all these different kinds of snowflakes, but this is work that requires further elaboration by some observer willing to devote a little time to this most interesting work of taking a picture of the snowflakes as they reach the earth. It has been said that the crystals in any given snowstorm have a family likeness, each storm, as it were, having its own particular type of snowflake. This is an interesting point to be settled only by careful observation, and for the present it is enough to recognize the fact that although snowflakes seem all very much alike yet there is endless variety in these "lovely blossoms of the frost."

It will be seen, then, that the conditions most favourable for the production of large snowflakes are when the atmosphere is freezing in some parts and thawing in others. With these conditions the process of regelation of moisture on the surface of the snowflake will proceed apace. Under such favourable circumstances very large flakes may be built up, although, as already mentioned, these large structures are often but the result of flakes that have collided in mid air and joined forces. These large snowflakes are like very large hailstones, which are often but a mass of ice formed by several hailstones crushed together. Both as regards the snowflake and the hailstones, these conglomerates are not properly to be taken as showing to what size a single flake or stone may grow. With this proviso it may be stated that one of these conglomerate snowflakes was found to measure $3\frac{1}{3}$ inches in length, $1\frac{1}{3}$ inches in breadth, and $1\frac{1}{3}$ inches in thickness; the flake when melted yielded $2\frac{1}{2}$ cubic inches of water. Such large snowflakes as this cannot come to maturity when the atmosphere is of a very low temperature all through. In such circumstances there are no alternate layers of air of varying conditions in temperature and moisture, and as a result only small, dry flakes of snow are produced. This is the kind of snow that falls in the polar regions, and it is these cold weather snowflakes that are the most perfect in form. Closely allied to the small and the large snowflakes is sleet. This commonly is objurgated as the most unpleasant of all the children born of the atmosphere, but it will perhaps be seen that rightly to understand the whole story of a snowflake, something of the changes in temperature that produce sleet need to be taken into account.

When lying on the ground, snow, from a meteorological point of view, is of much greater interest than when falling through the air. In an ordinary way there is a constant exchange of heat between the surface of the earth and the atmosphere. Thus during the day the sun pours its warmth down through the air to the earth, so that the surface of the ground is raised in temperature. During the night hours this acquired warmth is rapidly radiated into space, and the temperature of the earth accordingly falls. The atmosphere, moreover, that is everywhere in the closest intimacy with the ground, is also affected by this prodigal behaviour of the earth. Now, when the ground is wrapped round in its mantle of snow, these imports and exports of heat to and from the earth are interrupted. In other words, the diurnal range of temperature is greatly modified, so that all the time snow is on the ground there is not that excessive expenditure of heat that ordinarily takes place, and as a result the soil beneath the snow is maintained at an equable temperature.

Anyone who has been on the snow a few thousand feet above the level of the sea will have recognised the fact that snow is a good radiator of heat. At such a height, moreover, the atmosphere is dry and free from dust, so that as the heat rays pass through the air, to and from the surface of the snow, they have but little effect as regards raising the temperature of the air. Air such as this is said to be diathermanous, and heat rays passing through such territory, so to speak, pay no toll. Similarly snow, so long as it remains clean and free from impurities, reflects the heat rays, but will not absorb them. Supposing, however, that a little dirt or a plentiful supply of coal-dust settles on such snow, heat is at once absorbed, and the "frozen flowers" are destroyed. That the snow is white is considered to be due to the fact that the ice crystals of which each individual snowflake is built up, act as so many miniature prisms that blend the prismatic colours and so scatter a white light. In its embrace also, each snowflake as it lies upon the ground, holds a tiny supply of air, and it is this circumstance that makes the snow so bad a conductor of heat. Snow then in regard to the earth and the atmosphere acts as a buffer state, so that it passes no heat down from above and allows none to travel upwards from below.

Further, not only is snow of interest in the manner of its birth and in respect of its sojourn on the earth, but its actions are no less entertaining when it melts. In passing it may be observed that one foot of snow is considered to be equal to ten or twelve inches of rain. When, therefore, snow is on the ground to the depth of several feet there is an enormous quantity of moisture held in suspension. It is not surprising then that when a sudden thaw sets in, the water courses and rivers are unable to carry off the melting snow, and that floods result. At times, too, it will happen that the ground in the neighbourhood of fallen snow is frozen hard, so that as the snow melts it rushes impetuously onwards, disastrous floods being again produced. When the snow disperses in orderly fashion it percolates through the ground, and it will readily be understood that as the cold icy water passes downwards notable modifications occur in the temperature of the soil. At such times undrained land becomes saturated with the chilly water, and for this and other reasons it has been observed that the effect of draining land is the same as if it had been removed one hundred miles to the southward. It is not, therefore, surprising that in many countries considerable attention is given to the work of observing the snow, so that ample warning may be given to those whom it may concern of the time when it is beginning to melt.

Both when on the ground and when it melts it will therefore be seen that snow is constantly modifying the temperature of its surroundings. On the winds also which blow to and from the snow-covered areas these changes have also their effects, so that in studying climatic conditions it is imperative to know the times and seasons when a given locality is covered with snow. As already mentioned, to follow the biography of a snowflake to the end, something should be said concerning glaciers and icebergs; but it is sufficient for present purposes to call attention to them, with the observation that they were built by the snowflakes.

VEGETABLE MIMICRY AND HOMOMORPHISM.—V.

By Rev. Alex. S. Wilson, m.a., b.sc.

The resemblance of *Aseröe Junghu* to a sea-anemone was referred to in a previous article; this fungus attains a diameter of about a foot, is conspicuously coloured, and like Phallus, emits a fœtid odour; the gleba at its margins splits up into long narrow segments, which closely correspond to the tentacles of the zoophyte. The plant is a native of Java. Another remarkable member of the same family is the tropical Dictyophora, which is not unlike the common stinkhorn in shape, but is surrounded by a delicate white network which hangs expanded below the cap like a crinoline. This appendage, like the white corolla of a night-flowering plant, increases the conspicuousness of the fungus after dark. The Phalloidi occupy a somewhat exceptional position among fungi. Only some seven or eight per cent. of agarics, as Mr. Wemyss Fulton points out, are attractively coloured, seventy-four per cent. being brown, slaty or black. Ninety-one per cent. of the Phalloidi on the other hand, are red or white, warranting the conclusion that these colours are attractive to flies, which affect putrid substances. For this reason the Phalloidi are sometimes designated the "Flowering Fungi." This is the light in which Mr. Fulton also views the colours of the Amanitas, Mycenas and a number of the smaller agarics. Even the odour of putrefaction itself, he thinks, may be meant to

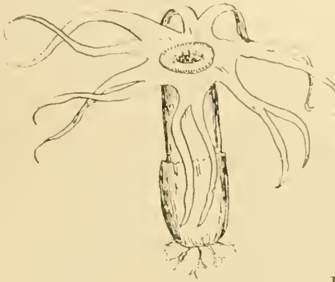


Fig. 21.—Aseröe, an anemone-like fungus.

Fig. 22.—Dictyophora, a flowering fungus.

attract flies which aid in the dispersion of putrefactive bacteria. Some of the marsh bacteria give rise to a jelly which floats as scum on pools and ditches. The beautiful rose-pink tint of this jelly which is full of these organisms may not improbably also be of use in promoting their dispersion. The attractive characters observed in fungi as a whole remind us of those flowers which are adapted to the visits of flies, beetles and other short-lipped insects. Gaily attired insects like the drone-flies manifest a preference for the more handsome blossoms, and are the most frequent visitors of the saxifrages, speedwells and forget-me-nots. The beautiful amethyst Clavaria seen amidst its surrounding of moss impresses the observer with the idea that this fungus lays itself out to attract the same class of visitors. Insects which themselves emit an odour likewise manifest a fondness for strongly-smelling flowers; the odoriferous bee Prosopis, for example, shows marked partiality for the strongly-scented flowers of rue and mignonette. The offensive odours of the Phalloidi, though specially attractive to flies, are in all probability repugnant to ruminants.

Numerous examples of interfungal resemblance have been described, and though most of these may be merely homomorphic, it is highly probable that at least some of them may be truly mimetic. Many years ago Mr. Worthington Smith directed attention to three British fungi which so closely resemble certain common species that minute examination is necessary to detect the difference. One of the species thus copied is bitter and nauseous, so that possibly the rarer kinds escape discovery by being mistaken for distasteful species. At least twenty species might be named, each of them closely simulated by another species. Dr. Plowright gives a list of twelve edible fungi, each imitated by one or more poisonous species. The Caesarian agaric, esteemed a delicacy in Italy, is copied by the poisonous amanita, or *vice versâ*, for it is not always possible to say which is the original and which the copy; the common mushroom has at least three imitators with poisonous properties—*Ag. melaspermus*, *Ag. fastibilis*, and *Ag. Taylori*; one can easily understand how fatal mistakes occur. Some of these resembling fungi are no doubt closely related, but in others the relationship is more remote, as in the case of a small agaric, referred to by Dr. Cooke, which resembles *Ag. cucumis* in a remarkable way and grows in the same situations. Both have the identical odour of decaying fish, but as the spores of the former are red, while those of the latter are white, they are classified in distinct and separate groups.

It has frequently been asserted that the spores of the common mushroom do not germinate unless they have been swallowed by some warm-blooded animal. Although this is denied by competent authorities, the fact remains that agarics are eaten by horses, cattle, sheep, squirrels and other animals. The partiality of certain fungi for animal droppings also favours the idea that some species at least are benefited in this way. On this assumption a poisonous species would profit by its resemblance to an edible species. On the other hand a conspicuous species with unwholesome properties might afford a model which edible species might copy with advantage, if their spores were incapable of withstanding the action of digestive fluids.

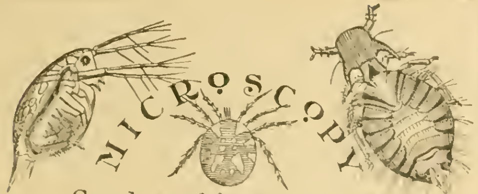
It is held by some that the function of the cystidia which occur along with the basidia on the gills of agarics is to fertilise the spores, and that to secure cross-fertilisation insect agency is necessary. This theory is by no means established, and in the present state of our knowledge it is impossible to say with any confidence whether the attractive characters of agarics promote dispersion or fertilisation or even to be sure that they are serviceable in any way.

The conditions under which plants live are not indeed such that the same amount of protection is required as in the case of animals, and it is hardly to be expected that their imitative powers should equal those of the animal world either in the extent to which deception is carried or in the variety of disguises assumed. The facts we have considered are sufficient, however, to show that in the two kingdoms of organic nature we have to deal with essentially the same phenomena.

The advocates of natural selection have constantly appealed with the utmost confidence to the evidence from mimicry in support of the theory, but this line of proof is by no means so convincing as has been supposed. No doubt the green colour of caterpillars may be easily accounted for by the extermination of the individuals which happened to be otherwise attired. Many facts, however, indicate that the explanation is not quite so simple; this line of reasoning would certainly lead us into error in the case of the flat fishes. When a flounder is transferred from a tank with sand to one with a gravelly bottom spots at once appear on the fish harmonizing with the gravel, due apparently to reflex action arising from an alteration in the light rays. Nature even seems to possess the secret of photographing in colours, for the pupae of several butterflies acquire the colour of the box in which they are kept. Accordingly Mr. A. R. Wallace, while attributing true mimicry as we have it in the butterfly Leptalis to natural selection, is constrained to refer the general similarity of tint to their surroundings which so many animals exhibit, to the action of light rays reflected from the environment. Our recently acquired knowledge of the Röntgen rays and their effects is not without a bearing on the question at issue. Many substances are known to emit invisible rays capable of giving rise to changes in the molecular arrangement of organic bodies. There can be little doubt therefore that the influence of radiant matter on the highly complex and plastic substances of living bodies has played an important part in bringing about those remarkable resemblances which are included under the terms mimicry and homomorphism. Such considerations do, however, detract very seriously from the value of natural selection as a factor in organic evolution; so far as mimicry is concerned there is little left for natural selection to do, only the finishing touches, so to speak.

The phenomena of homomorphism are also to some extent adverse to the Darwinian theory. If we assume with Darwin that variation is fortuitous the law of probabilities forbids us to expect coincidences like that observed in the orchids and asclepias. In dealing out cards, for example, the chances against a player receiving the same set a second time are very great, and the improbability increases in a geometrical ratio as the number of cards is increased; with a large number of cards the improbability is infinitely great. There is the same kind of improbability and that in a high degree against the production through fortuitous variation and natural selection of those coincidences which are so frequent in the organic world. Darwin felt the force of this objection, which he met by saying—"As two men have sometimes independently hit upon the same invention, so it appears that natural selection working for the good of each being and taking advantage of all favourable variations has produced similar organs, as far as function is concerned in distinct organic beings which owe none of their structure in common to inheritance from a common progenitor." But this reply does not quite dispose of the difficulty; the two cases are not strictly analogous; to make them parallel we should have to suppose that two men accidentally and quite unintentionally alighted upon the same invention—a rare occurrence indeed. Yet such a supposition is necessary in order to eliminate the element of intelligent investigation on the part of the two inventors, to which there is nothing corresponding in natural selection. When two similar variations have arisen natural selection sufficiently accounts for their preservation; the difficulty is the appearance at two or more points of the organic system of identical variations. That this has occurred again and again goes to show, either that the environment has exercised a definite influence in generating particular variations, or that there is in organisms an innate tendency to vary along certain lines. In any case variation cannot be fortuitous, but must have its course dominated by fixed, though it may be unascertained laws. There is profound biological truth in Emerson's words: "Nature's dice are always loaded."

But a still wider question confronts us. If resemblances can arise among organisms apart altogether from hereditary relationship what, it may be asked, becomes of the argument for organic evolution based on similarity of structure? If, as Darwin admitted, the eye of a cuttle-fish and the eye of a vertebrate had an independent origin, may not the same thing hold good in regard to many of those likenesses to which evolutionists appeal in support of their theory? Homomorphic is differentiated from hereditary resemblance by the absence of connecting forms. The evolutionist postulates the former existence of innumerable intermediate forms. If these never had any existence then the alternatives are either evolution *per saltum* or independence of origin. Between the inorganic and the animate no intermediate forms are conceivable; we are therefore compelled to assume an independent origin for life. And although we cannot form a definite conception of such an occurrence, few naturalists nowadays will be satisfied with a single primitive type as the original source of all the manifold forms of life. But whatever view we may hold on this point, it is impossible to conceive of the successive advances in the organization of plants and animals which have taken place in past geological time apart from corresponding accessions of vital energy.



Conducted by M. I. CROSS.

POND-LIFE COLLECTING IN OCTOBER.—October is one of the best months for the pond-hunter; the weather is cooler, the ponds have become filled with rain-water again, with plenty of food material in the shape of flagellate Infusoria, and the Crustaceans are on the decline. In this month the greatest variety in species of Rotifera is usually found, particularly of the smaller and rarer kinds, and not infrequently thirty to forty species may be obtained in one or two small ponds. As a general rule one cannot expect much variety when a few species are present in excessive abundance. The following is a list of forty-four species of Rotifers actually collected on one occasion in three ponds on October 15th, 1898, showing what may be looked for:—*Floscularia regalis*, *ornata*, *cornuta*, *ambigua*, *edentata*, and *annulata*; *Limnias annulatus*, var. *granulosus*; *Oecistes crystallinus*; *Philodina megalotrocha*; *Rotifer vulgaris*; *Synchaeta tremula* and *oblonga*; *Asplanchna priodonta*; *Notops hyptopus*; *Polyarthra platyptera*; *Eosphora aurita*; *Furcularia longiseta*, *sterea*, and *forficula*; *Proales felis*; *Diglena biraphis*; *Mastigocerca rattus* and *bicornis*; *Coelopus porcellus* and *tenuior*; *Rattulus bicornis*; *Diaschiza exigua*; *Distyla flexilis*; *Monostyla lunaris*; *Dinocharis pocillum*; *Stephanops lamellaris*; *Cathypna luna*; *Euchlanis oropha*; *Metopidia acuminata*; *Brachionus angularis* and *bakeri*; *Pompholyx sulcata*; *Notholca labis* and *scapha*; *Anuraea aculeata*, *cochlearis*, *tecta*, *hypelasma*, and *stipitata*. On the other hand, the various kinds of Rotifers known as summer forms will now have disappeared. *Pedalion mirum* is such a form which may occasionally still be seen during a warm October, but is then usually very scarce or absent.

MICROTOMES (*continued*).—It is impossible to give descriptions of all the different microtomes, even if one eliminates those that do not possess special merit or qualities. It will only be possible to name two or three, and if further information is required about them it can be obtained from any of the usual dealers.

Leitz and Reichert both make good sound microtomes, the latter having a high reputation for his continuously working micrometer screw upon the rivet model. This continuous working is brought about by simple means, viz., when the screw has reached the limit of its movement, it is turned through 180° so that its opposite extremity points towards the object-holder, when the working can at once be continued.

The Minot microtome for the paraffin ribbon method, by Zimmerman, of Leipzig, is a very excellent form, and Becker also makes one on the Schanze and Minot models. The former is worked by rotating a balance wheel, whose rotary action is changed into a vertical movement of the object slide by means of a crank action. When the object slide is moving upwards, a lever strikes one of the spokes of the rachet wheel which, in turn, moves the large toothed wheel of the horizontal micrometer screw, thus advancing the object towards the knife; it works with great rapidity, and cuts sections up to 2 × 2″ with exactness and absolutely flat.

The Reinhold Giltay model has points of both ingenuity and originality; it is constructed for the paraffin process. It is mounted upon an iron stand with a wooden cover, in a similar manner to a sewing machine; the working parts are compensated for wear and tear, and it is constructed on similar principles to the Minot from which it differs in the feed adjustment. This is effected by the slide of the knife block towards the object by means of a micrometer screw passing through the block, the movement of the object being restricted to the vertical direction.

The microtomes of Schanze, of Leipzig, have many features which may fairly claim for them special attention and favour; they are second to none in accuracy and beauty of workmanship, and are unexcelled for general utility.

In order to do work with the microtome, there is certain accessory apparatus which is necessary, and on which will materially depend the success or failure of the early experiments. Knives will have to be selected, and the beginner will find a bewildering number of patterns from which to make his choice. For general paraffin cutting with sledge microtomes, the Henking pattern knife, having a blade 6 cm. long and the handle 9 cm. long, is probably the best. Jung's pattern, in which the blade fits into an ebony screw handle is another useful form. It may be employed for cutting at right angles to the microtome guides or obliquely, with a slicing cut, provided that the knife is of suitable size for the microtome.

Other patterns in use are Weikert's, with a straight handle, and both sides of the blade concave for cutting celloidin embedded objects under fluid; and Thoma's, or the Heidelberg pattern, with a curved handle having the underside flat and the upper side concave. The latter does the same work as the Jung pattern already referred to, but does not require a special holder, as it fits directly to the carrier of the microtome.

The sharpening of the knives is a very important process, and, excepting this is carefully attended to, it is utterly impossible to cut good sections. Some brief instructions on these matters appeared in KNOWLEDGE, July number.

A few words may be added to emphasize the necessity for the proper preservation of the objects that are to be cut into sections. Living organisms or parts of them must be taken at the time of robust health and killed and fixed instantaneously, with the substances best suited for obtaining the desired results. All the fixatives known to science will not preserve the lifelike stages in the histology of the subject when once post-mortem changes have taken place. The subject of fixing, embedding in celloidin and paraffin, staining *en bloc*, and mounting generally, are so fully treated in books on these specific subjects that the space available in this journal will not admit of treating each of the processes in detail.

There is one important point, however, with regard to paraffin for embedding; different writers disagree as to the melting point of the wax that should be used; as a matter of fact, all grades are useful, and the melting point of the paraffin will depend on the temperature of the laboratory in which the work is done and the thickness of the sections required. If the room is 15° C., and sections are required 10 μ thick, paraffin with a melting point of 45° C. will be suitable; but for sections 5 μ thick with the same room temperature, a higher melting point of paraffin must be employed, say, 48° C. or 50° C., and for sections 1 μ thick, and the same room temperature, the wax must have a still higher melting point, and *vice versâ*.

If the paraffin is too soft for the temperature of the work-room and thickness of sections, then the sections will probably crumble together; if the paraffin is too hard the sections will curl or roll upon the knife.

System in this work, as in everything else of so precise and delicate a nature, is the one important thing: nothing must be done in a hurry, but every stage carefully arranged for and anticipated.

PRACTICAL SCHEME.—Through the courtesy of a reader we are able to offer to such as may wish to avail themselves of it, material for distribution.

It consists of Basal Reef Rock, containing a variety of organisms living in comparatively shallow tropical waters, probably in Pliocene time, as well as interesting inclusions of the older oceanic beds:—Globigerina in rock; Radiolaria in rock; Diatoms in rock. These should properly be ground for microscopical examination.

The supply is not a very extensive one, but it is of special interest, and will be forwarded to applicants on receipt of stamped addressed label, together with the coupon which will be found in the advertisement pages.

NOTES AND QUERIES.

J. S.—The light-dispersing power of the glow-worm has been attributed to several causes. It was at one time thought to be caused by phosphorous, but this theory has not been confirmed by later researches. Some experiments have been conducted by a French naturalist, who proved that the illumination is used as a means of signalling between individuals of the same species. He placed a glow-worm in a glass tube, but it emitted no light until others of the same species approached; then to attract their attention it emitted jets of light in rapid succession.

These were responded to by the other insects and the moment the imprisoned one was assured that it had attracted the attention of the new comers, it ceased to emit light.

Lt. Damant.—The study of marine life covers such a very broad area that you would almost need a library for the purpose of identification of specimens. Probably one of the most comprehensive books you can have would be the Micrographic Dictionary, costing £2 12s. 6d., Carpenter's "Microscope and its Revelations," edited by Dr. Dallinger, ought also to be of material assistance to you; the cost of this is 28s. Probably your best plan would be to get into communication with one of the Marine Biological Stations, from whom you could no doubt obtain particulars of the most suitable apparatus and processes. The two best microscopical societies are The Royal Microscopical Society and The Quekett Club; both of them meet at 20, Hanover Square, London, W. You would find their journals helpful. The 2″ objective would be a useful addition to your equipment. I am very much obliged for your offer to collect material.

Algæ.—A correspondent has pointed out a slip which occurred in the Algæ article last month, on page 212, column 2, paragraph 4. For "chloride of lime" read "carbonate of lime." Readers might also note that if tufts of seaweed, which are not in a growing condition, are required to be kept for any length of time, they must be preserved in strong salt water or glycerine—they will not keep long in sea-water.

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.

New Comet.—Mr. C. D. Perrine, of the Lick Observatory, Mount Hamilton, discovered a new comet on the morning of September 1st, about 6° S.S.E. of the variable star Algol. From computations which have been made it seems the perihelion passage will take place on November 23rd, and that the comet is approaching us and rapidly becoming brighter. Its position is exceedingly favourable for observation in the northern hemisphere. At the beginning of October the comet will be in or near the head of Cepheus, and may be readily found, as it will be tolerably conspicuous and probably visible to the naked eye. During the month named its motion will become increasingly rapid, and in a direction approximately towards the sun's place.

The following ephemeris for Greenwich midnight has been computed by Dr. D. Smart, of London, from Strömgen's parabolic elements :—

Date 1902.		R.A. H.	M.	S.	Declination. °	′	Brightness. Sep. 1 = 1
September 30	...	23	32	12	+ 57	1	16·0
October 4	...	21	22	32	52	50	22·8
„ 8	...	19	42	4	40	14	25·7
„ 12	...	18	44	24	26	4	23·2
„ 16	...	18	10	56	14	48	19·1
„ 20	...	17	49	36	6	43	15·7
„ 24	...	17	34	32	+ 0	55	13·6
„ 28	...	17	22	48	− 3	24	12·3

Tempel-Swift's Comet (1869 III.).—We may shortly expect to hear of the re-discovery of this well-known periodical comet. Its time of revolution is as nearly as possible $5\frac{1}{2}$ years, for its first observed perihelion occurred on 1869, November 18, while the last took place on 1891, November 14, the comet having, in the interval of 22 years, completed four circuits of its orbit. The position of its path and length of its period are such that the object can only be observed at alternate returns to perihelion, for at its approaches to the sun in 1875, 1886, and 1897, the comet was placed on the opposite side of the sun to the earth, and therefore rendered invisible by two causes, viz., its great distance and the interference of solar light. It owes its first discovery to Tempel, at Florence, on 1869, November 27, when it was situated near the star α Pegasi, and appeared as a faint object about $2\frac{1}{2}$ minutes of arc in diameter. It was re-detected by Lewis Swift at Rochester, New York, on 1880, October 10, and after a few observations had been obtained, Chandler and Schulhof pointed out the similarity of its elements with that of Tempel's comet of 1869, and inferred a period of $5\frac{1}{2}$ years. This was verified by the reappearance of the comet in 1891, and it will doubtless be seen again during the ensuing autumn. Visible only as a faint telescopic object, it cannot be said to possess any specially attractive features for the observer, but astronomers regard it as a very interesting example of the Jovian family of comets, the number of which has been greatly increased in recent years, owing to the assiduity and success with which comet-seekers have pursued their labours.

Fireball of August 21, 14h.—Astronomical observers appear to have been caught napping on the early morning of Friday, August 22, when one of the most brilliant and remarkable meteors of recent years made its apparition. Apart from its unusual size, the exceptional features about it were its extreme slowness of motion, its great length of path, and the dense tail of sparks which it left behind. About twenty descriptions have come to hand from casual observers, and it may be interesting to quote some of the details:—

Mr. J. E. Sanders, Plymouth, was on board a ship abreast of Mewstone when there suddenly appeared a very bright light with a large head, which travelled at a great pace. It lit up sea and land for miles around as if it were day. Rising in the W.S.W., it travelled in an horizontal position to the E.N.E., passing 10 or 12 degrees below the moon, and leaving a long curved tail in its wake. Its duration was about 2 minutes. Mr. Sanders says that though he has been 33 years at sea, and travelled in all parts of the world, he has never seen any celestial sight comparable with that of the fireball.

Mr. J. Durston, Plymouth, was on the Hoe, and says the meteor was of great length, large head with slightly curved tail, and magnificent brilliance. It sped across the sky at a terrific rate perceptibly (to all appearance) dividing the lower strata of cloud. It was travelling from W.S.W. to E.N.E., and apparently broke up at the end, after being visible 30 seconds. First seen in azimuth, S. 71° W., and disappeared in azimuth, E. 5° S.

At St. Agnes, Cornwall, a spectator says it was first noted away in the south as a star of great brilliancy, moving very slowly round to the N.E., and disappearing at the horizon without having spent itself. It had no tail, and it kept at the same apparent altitude throughout, though it travelled a very long distance. The St. Agnes observer adds that this is doubtless "the same object as seen by Mr. Durston at Plymouth, but with this difference, that no tail was visible at St. Agnes, and that its speed was excessively slow."

Dr. Wm. Whitworth, of St. Agnes, describes it as appearing in the south and disappearing in the N.E., after traversing a most unusual length of sky. The speed was comparatively slow; the ball of fire seemed to glide rather than shoot through the air. Altitude 20° or 25°, duration 40 seconds.

"R. J. W. M.", writing from Sandquay, Dartmouth, says the meteor appeared at 2h. 5m. a.m., and travelled very steadily across the sky from W. to E. It had the aspect of a perfectly round blue ball without a tail.

R. R., Devonport, was on board a pilot boat close to the Eddystone Lighthouse when he suddenly saw an object as bright as the moon, and with an enormous tail of fire, taking an horizontal flight right across the heavens, and increasing in brilliancy in its travel until near the E. horizon, when it died out. Duration 30 seconds.

Polperro fishermen observed the meteor. It was "awfully grand and visible for a long time," passing straight across the sky from S. of the Dodman to N. of Rame Head, shooting out a tremendous number of stars along its course. "Sailors who have sailed in many seas aver they never saw anything like it before."

A Southampton correspondent alludes to the meteor as appearing over the River Test side of Southampton Water, and travelling with phenomenal slowness from W. to E. It looked like a great ball of fire, and left a very long trail of electric blue sparks in its wake.

Mr. W. H. Rowe, Leigh-on-Sea, gives the time as 14h. 2m., and says he watched the fireball pass from S. 15° W., altitude 8°, to S. 67° E., altitude 8°. Diameter $\frac{1}{5}$th that of moon. Tail of brilliant fragments, dying out 2° from the nucleus. Duration 30 to 35 seconds.

Mr. C. F. Dowsett, Basingstoke, says the fireball passed in a straight line from W. to E. Portions seemed to descend from it, while the larger part continued its flight. It appeared travelling at the same rate as a train making 40 miles an hour. The position where he lost sight of it was a little S. of E.

Messrs. Blythe and Shorney, Tamworth, near Birmingham, describe the meteor as leaving few sparks behind it. It moved horizontally and very slowly towards the E.

At Sidcup, Eltham, it was very brilliant; travelled quite slowly in an horizontal path. Duration probably half a minute.

At London it passed from west to east across the sky, and its direction was parallel with the horizon. Its duration of flight was half a minute, and it developed a tail like that of a comet. Three Australian troopers, who were standing at Hyde Park Corner, say it appeared to travel horizontally towards the S., that it was visible about 3 minutes, and had a long tail.

From these and a few other accounts, which are not, however, very definite and satisfactory, the following approximate real path has been derived :—

Height at beginning	..	59 miles over a point in lat. 47½° N., long. 9½° W.
Height at ending	...	27 miles over a point in lat. 50½° N., long. 4° E., near St. Omer, France.
Length of path	...	611 miles.
Velocity ..	...	15¼ miles per second
Radiant point	..	283° − 10½° low on W.S.W. horizon.

The fireball traversed the whole length of the English Channel, and in a direction from W.S.W. to E.N.E., nearly parallel with the south coast of England. The observed path was abnormally long. The velocity is obtained by adopting 40 seconds as the whole duration. The observations furnish some contradictions, and it seems impossible to deduce any very exact results from them.

THE FACE OF THE SKY FOR OCTOBER.

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

THE SUN.—On the 1st the sun rises at 6.1 and sets at 5.39; on the 31st he rises at 6.52 and sets at 4.35.

The sun rises partially eclipsed on the 31st, the eclipse ending at 7.1, only nine minutes after sunrise.

THE MOON:—

		Phases.	h. m.
Oct. 1	●	New Moon	5 9 P.M.
„ 9	☽	First Quarter	5 21 P.M.
„ 17	○	Full Moon	6 1 A.M.
„ 23	☾	Last Quarter	10 58 P.M.
„ 31	●	New Moon	8 14 A.M.

The moon is in apogee on the 8th, and in perigee on the 20th.

An eclipse of the moon takes place on the morning of the 17th, the earlier phases of which are visible from this country, but the moon sets at Greenwich at 6.32 A.M., totally eclipsed. In America, however, the whole phenomenon will be observable.

Further particulars of the eclipse, and a diagram showing the path of the moon through the shadow, are given in another column.

Occultations:—

Date.	Star Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
			h. m.	°	°		°	°	d. h
Oct. 12	c^2 Capricorni	6·2	9 48 P.M.	70	55	11 2 P.M.	243	217	11 5
„ 16	ζ^1 Piscium	4·2	10 17 P.M.	100	116	11 18 P.M.	213	216	15 6
„ 20	δ^1 Tauri	4·0	5 8 A.M.	84	51	6 13 A.M.	270	231	18 12
„ 20	δ^2 Tauri	4·7	5 43 A.M.	108	71	6 43 A.M.	247	207	18 12
„ 23	λ Geminorum	3·6	0 53 A.M.	58	98	1 41 A.M.	311	349	21 8

THE PLANETS.—Mercury is too near the sun for observation at the beginning of the month, being in inferior conjunction on the 19th. During the last week of the month, however, he is fairly well placed, rising about 1½ hours in advance of the sun. He is near Spica on the 22nd, and Venus on the 23rd.

Venus is a morning star in Virgo, and rises about an hour before the sun. She is near Spica Virginis on the 24th. About the middle of the month 0·98 of her disc is illuminated.

Mars is a morning star in Leo, rising about 1 A.M. He is near the star Regulus on the 21st. His apparent diameter is increasing, being about 5″·0, whilst 0·93 of his disc is illuminated.

Jupiter is the most conspicuous object in the evening sky, and is so bright that it can be discerned long before it is dark. Near the middle of the month the planet is on the meridian about 7 P.M., and sets at 11.30 P.M.; his apparent diameter is decreasing, being now about 39″. The retrograde movement of the planet ends on the 4th, when he is stationary, after which his motion will be direct or easterly. On the evening of the 11th he will be near the moon. The more interesting phenomena of the satellites which may be observed are as follows:—

			H. M.				H. M.
2nd.—	II. Tr. I.	...	5 36	21st.—	I. Tr. I.	...	5 38
	IV. Ec. R.	...	7 4		I. Sh. I.	...	6 58
	II. Sh. I.	...	7 59		I. Tr. E.	...	7 59
	II. Tr. E.	...	8 33		I. Sh. E.	...	9 18
	II. Sh. E.	...	10 55	27th.—	II. Sh. I.	..	5 6
5th.—	III. Sh. E.	...	6 56		II. Tr. E.	...	5 20
	I. Tr. I.	...	7 25		IV. Sh. I.	...	6 29
	I. Sh. I.	..	8 37		II. Sh. E.	...	8 2
	I. Tr. E.	...	9 45		I. Oc. D.	...	10 24
	I. Sh. E.	...	10 58	28th.—	I. Tr. I.	...	7 33
19th.—	III. Tr. I.	...	5 58		I. Sh. I.	...	8 53
	III. Tr. E.	...	9 40		I. Tr. E.	...	9 53

Saturn is about 16 degrees west of Jupiter, and souths at the middle of the month at 6 P.M., setting at 10 P.M. The planet is in quadrature with the sun on the 15th. On the 7th the apparent outer major and minor axis of the ring are 39″·27 and 15″·64 respectively, while the polar diameter of the ball is 15″·6. The ring is widely open.

Uranus is too near the sun for observation.

Neptune may be observed before midnight throughout the month, rising on the 1st about 9.30 P.M., and on the 31st about 7.30 P.M. The planet is near to μ Geminorum, and should appear in the same field of view as the star throughout the month, if observed with a low power eyepiece. Their positions are as follows:—

	R. A.	Declination.
Neptune (Oct. 8th)	6h. 16m. 6s.	N. 22° 16′ 27″.
μ Geminorum	6h. 17m. 5s.	N. 22° 33′ 42″.

THE STARS.—About 9 P.M. at the middle of the month, the following constellations may be observed:—

ZENITH	.	Cygnus, Cepheus, Cassiopeia.
SOUTH	.	Pegasus, Aquarius, Capricornus, *Fomalhaut*.
WEST	.	Lyra, Hercules, Ophiuchus, Corona; Boötes to the N.W.; Aquila to the S.W.
EAST	.	Andromeda, Aries, Perseus, Pleiades; Aurigae to the N.E.; Cetus to the S.E.
NORTH	.	Ursa Major, Ursa Minor, Draco.

Chess Column.

By C. D. LOCOCK, B.A.

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

Solutions of September Problems.

No. 13.

Key-move.—1. Kt to KKt 5.

If 1. . . . P to Kt6, etc.,	2. Q to B2, etc.
1. . . . B to B3,	2. Q to Kt3ch, etc.
1. . . . Kt to B6,	2. Kt to B7ch, etc.
1. . . . K to Q3,	2. Q to B8ch, etc.
1. . . . K to Q5,	2. Kt to K6ch, etc.

[More than one solver has been deceived by the "try," 1. Kt to B5. The only defence is Kt to B8. There is a dual after 1. . . . K to Q3, by 2. Q to K3.]

No. 14.

Key-move.—1. Q to KB8.

If 1. . . . K to Q4,	2. Q to B5ch, etc.
1. . . . K to K3,	2. Kt to B4ch, etc.
1. . . . B to K3,	2. Q to B3, etc.
1. . . B to B2,	2. Q × B, etc.
1. . . . P to Q4,	2. Q to K7ch, etc.
1. . . . Anything else,	2. Q to KB5, mate.

No. 15.

There appears to be no solution, the author's intention (1. Q to QKt8) being defeated by 1. . . . P to QKt8.

SOLUTIONS received from W. Nash, 5, 4, 4; Alpha, 0, 4, 0; W. Jay, 5, 4, 4; G. Woodcock, 4, 4, 0; G. W. Middleton, 5, 0, 0; W. de P. Crousaz, 0, 4, 0; "Tamen," 4, 0, 0; C. Johnston, 0, 4, 4; "Looker-on," 5, 4, 4; J. W. Dawson, 3, 4, 4.

Tamen.—As you say, your solution of No. 14 was just too late to score.

G. Woodcock and *Alpha.*—In No. 15, 1. Q × P is met by 1. . . . R to Q4.

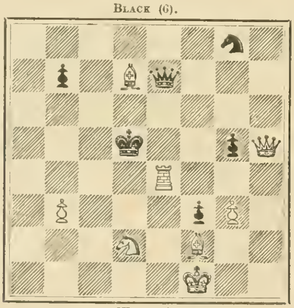
Note.—Failure in the case of No. 15 is no disqualification for taking part in the judging of the sound problems. Nevertheless I expect to extend the list to those who fail not more than twice in the case of sound problems.

PROBLEMS.

No. 16.

"Without hope."

BLACK (6).



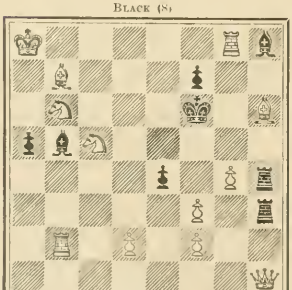
WHITE (8).

White mates in three moves.

No. 17.

"Brutum Fulmen."

BLACK (8)



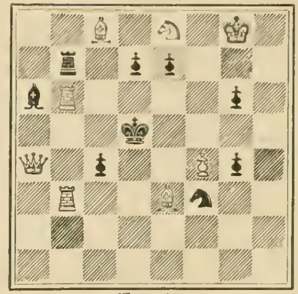
WHITE (12)

White mates in three moves.

No. 18.

"Bargany."

BLACK (9).



WHITE (8).

White mates in three moves.

CHESS INTELLIGENCE.

The Newnes Challenge Cup, which carries with it the Amateur Championship of the long defunct British Chess Association, was competed for at the Southern Counties' Tournament, held at Norwich last month. Mr. H. E. Atkins, who has held the cup for some years, did not defend his title, and the winner proved to be Mr. R. P. Michell, the well-known London amateur. The other competitors included Dr. Dunstan, and Messrs. Blake, Jacobs, Mortimer, Sherrard, Wainwright, F. Brown, Loman, and R. F. B. Jones.

The final tie for the Championship of the S. C. C. U. resulted in a fiasco, Gloucestershire, who were looked upon as almost certain winners, after the defeat of Surrey, being unable to raise a team during the holiday season. The result was that Norfolk, the winners of the North-Eastern Section, became the Champion County.

The death is announced of Mr. E. B. Schwann, the well-known player and problem-composer. Mr. Schwann was acting as Hon. Sec. to the delegates of the counties who were recently attempting the formation of a National Chess Federation.

Owing to the postponement of the World's Fair, the Seventh American Chess Congress, which was to have been held next year, has been put off till 1904.

All manuscripts should be addressed to the Editors of KNOWLEDGE, 326, High Holborn, London; they should be easily legible or typewritten. All diagrams or drawings intended for reproduction, should be made in a good black medium on white card. While happy to consider unsolicited contributions, which should be accompanied by a stamped and addressed envelope, the Editors cannot be responsible for the loss of any MS. submitted, or for delay in its return, although every care will be taken of those sent.

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

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CONTENTS.

STUDIES IN THE BRITISH FLORA.

By R. LLOYD PRAEGER, B.A.

VI.—THE LIFE AND DEATH OF BOGS.

WHEN deep turf-cuttings in a bog expose the base of the peat and the beds which underlie it, these, as has already been pointed out, frequently consist of white lake-marls; in other instances of black mud, the result of marsh conditions; or the peat may rest direct on gravel or Boulder clay or solid rock. It may be assumed fairly that a bog—that is, a spongy sphagnous vegetable mass—has generally had its origin in a marsh, which may in its turn have taken the place of a lake or pond. The marginal vegetation of a pond protrudes from the edge as a floating rim, which keeps on growing above, while the lower layers decay and their waste drops to the bottom and slowly builds up a solid foundation for the broadening rim, till the whole is filled with semi-solid ground. Every stage, from the open lakelet full of Charas and Pondweeds, which grow on the limy bottom, to the marsh with its tangle of Rushes and Sedges, may be studied in any locality where small sheets of water abound. The passage of marsh to bog is not so easily found, just as on the hill-slopes we fail to find fresh peat-bog forming on areas not already covered with peat. The explanation would appear to be that, as a matter of fact, fresh bogs are *not* forming—but more of this anon.

We may assume that when our peat-bogs were in their infancy, *Sphagnum* and its associated plants took possession of the ground when marshy growth had proceeded sufficiently far to ensure a permanently wet spongy subsoil. Once bog-growth was started, under the favourable climatic conditions which then prevailed, it may have proceeded with great rapidity, the bog-plants checking drainage, storing up water, and spreading ever from their centre. In this way the bogs rolled slowly outwards from the marshes or springs where they originated, and eventually overwhelmed great areas that had been well-drained land. On the hills, where higher rainfall gave increased facilities, the bogs spread up and down the slopes, enveloping whole mountain-ranges in a vegetable covering.

The lower layers of our peat-bogs are usually full of the stumps and roots of trees. The whole of the bog sometimes overlies these old forests, which, in such cases, as the roots show, grew on the surface of the clay or gravel which the bog afterwards covered. But in most instances the trees are rooted *in* the peat, and sometimes successive layers of tree-stumps show that several epochs of forest-growth occurred during the accumulation of the peat. The distribution of these trees, consisting chiefly of Scotch Fir and Oak, buried in bogs, deserves special consideration. They are found to extend in Scotland far north of the present limit of the species, while in Ireland, where the Scotch Fir is now extinct as a native, the remains of this tree occurs in enormous quantity throughout the land. In both countries the old forests appear at elevations in the mountains far beyond the present upper limit of the species. Along the exposed western coasts of Scotland and Ireland, enormous stumps may be dug out at various levels where now, even with artificial protection, trees will not grow. Not only that, but in numerous places round our shores, between tides, or even far below low-water mark, tree-bearing peat occurs. So that the evidence of the trees of the lower part of our peat-bogs indicates not only a somewhat different climate, which allowed a much wider extension of these forest-growths, but a greater elevation of the land. At Belfast a bed of peat, with Hazel and Scotch Fir remains, and bones of Red Deer and Wild Boar, occur at 27 feet below high-water mark, and the beds which overlie it prove that subsequent to its deposition a depression of 50 or 60 feet took place, followed by 30 or 40 feet of upheaval.* And not only have the sea-beaches and sea-bottom where these submerged trees occur been dry land, but, as Prof. James Geikie points out,† the luxuriance of the forest-growth which formerly flourished on what is now exposed and treeless coast, shows that at that period the shore-line must have been some distance removed; "there can be little doubt that at some time during the latest great extension of the European continent, the upraised beds of the Irish Sea, the English Channel, and the German Ocean, were included under the folds of that broad mantle of green forest, the relics of which are so conspicuous in our peat-mosses." Such an extension of the land would undoubtedly assist in supplying the comparatively continental climate and lessened exposure which would

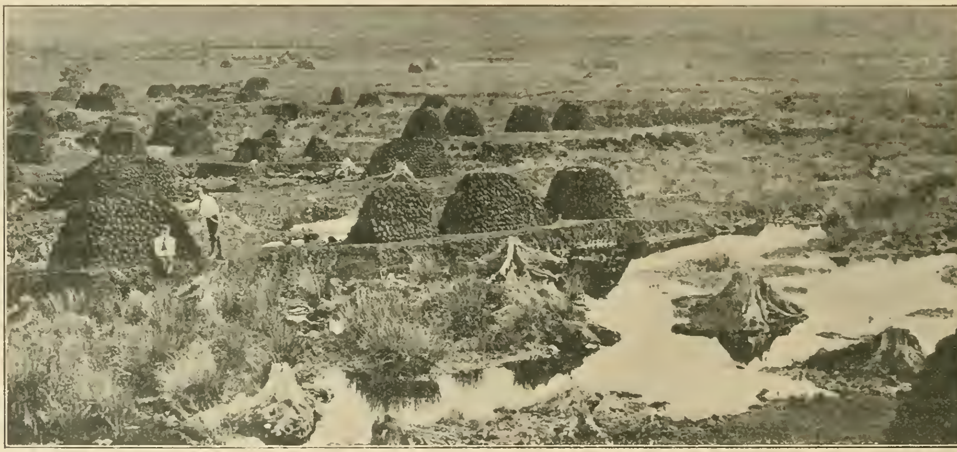
* Praeger: "On the Estuarine Clay at the new Alexandra Dock, Belfast." *Proc.* Belfast Nat. Field Club, 1886-87. Appendix.

† James Geikie: "On the buried forests and peat-mosses of Scotland, and the changes of climate which they indicate." *Trans.* R. Soc. Edinburgh, XXIV., pp. 363-384. 1866.

account for the former wide distribution of pine and other woods. Similarly, the passing away of the forests, and their replacement by *Sphagnum* and the bog-flora, might well be connected with those geological changes which, giving our islands their present contour by depression of the land, brought in a milder and wetter insular climate. In our great peat-bogs, these forest-growths are confined to the lower layers. The main mass of the peat has been formed by *Sphagnum* and its associated plants after the forests passed away, and under the influence of a wet Cold-Temperate climate. The old forests have been deeply buried, and the bog-flora has reigned supreme in the British Isles, especially in the north and west, and since the beginning of history has furnished the most remarkable feature of the floral characteristics of our country.

So much for the origin and growth of bogs. Like everything else on this earth, their life is limited. They do not go on growing for ever, and it would seem that the Age of Bogs, as we may call it, through which these countries have been passing for the last few thousand years, is now on the decline. Prof. James Geikie is of opinion that bog-growth is waning in Scotland. Regarding this he speaks with no uncertain voice:—"A glance at the present aspect of our peat-mosses will convince any geologist that this formation has not only ceased to spread, but is in most cases rapidly diminishing. The moisture which in former times afforded it nourishment and support, has now become its chief enemy. Every shower of rain, every frost, gives fresh impetus to the decay; and leaving altogether out of account the operations of agriculture, we can yet have no doubt that natural causes alone would, in time, suffice to strip the last vestige of black peat from hill and valley. . . . The peat-mosses of Scotland are thus only a wreck of what they have once been."*

On the Irish bogs the signs of decay are not so general nor apparent, but many interesting individual cases may be studied. On the great red bogs of the Central Plain, bog-moss or *Sphagnum*, the plant which has been chiefly instrumental in building up the bogs, still grows luxuriantly, and there is no indication in many cases that the bogs are not still growing as fast as they ever grew. But on some bogs the luxuriant cushiony growth of *Sphagnum*, mixed with *Eriophorum*, *Narthecium*, *Rhynchospora*, gives place to a thin scrubby vegetation from which *Sphagnum* is absent, and among which the bare sodden peat continually forms black patches. Such a bog, though on level ground not yet actually wasting away, is dead so far as growth is concerned. Elsewhere a luxuriant crop of Ling replaces the many-coloured *Sphagnum*, and tells of a diminution of water supply. Such a bog is near its end, for Ling cannot form peat. But it is on the hills, among the black bogs, that signs of decay are most clearly evident, just as Prof. Geikie has pointed out as regards the Scottish hills. Thus, Kippure (2473 feet), the highest point of the Dublin hills, shows, even at a distance of some miles, a slightly serrated crest. This is found on ascending to be due to the fact that the great cap of peat, 12 feet or more in thickness, has been cut into by wind and rain, and eaten away till stretches of bare disintegrated granite alternate with great bastions of peat, capped with a growth of Ling. Peat so exposed will disappear rapidly. Rain, frost, and drought alike play havoc with it, and wind and streamlets carry it down the hill-side. In many other places, where deep deposits of peat prove a former luxuriant bog-flora, the vegetation now consists of dry wiry grasses, such as *Nardus stricta*, with stunted Ling and Whortle-berry. Such a plant-group will never form peat; the plants which made the deposit on which they grow are dead and gone. To compensate for the decay of the peat-flora, we do not find that in any portion of the country fresh bogs are forming; and we are driven to conclude that the formation of peat is on the decline. While man's operations are responsible for the destruction of much peat, by turf-cutting and by drainage and cultivation, this cause is wholly insufficient to account for the facts, as the best instances of bog decay are seen in situations which the operations of man have never extended to, or even indirectly affected. Some change of conditions must be looked for which has affected the whole country, and Prof. Geikie



Scotch Fir, with Peat above and below it; Co. Antrim.

[R. WELCH, *Photo.*

* *Loc. cit.*, pp. 381, 382.

concludes, with much reason, that it is probably to be sought in a gradually diminishing rainfall.

There is another manner in which a bog may meet destruction—a way which is always dramatic, and sometimes may involve serious catastrophe. This happens when, owing to continual growth, the bog becomes unstable, and either slides bodily, or ruptures its walls and emits its contents. In order to understand how this takes place, we must study the structure of a bog. The thirty or forty feet of material which in a large peat-bog separates the surface from the underlying solid ground is not by any means of a consistency as firm as that of the surface layer. The intertwining stems and roots of the growing plants form a light matted felt which is comparatively firm, especially towards the margins of the bog; in the centre there are often holes in the crust, filled with mud or water, and connecting with the interior. This interior is fluid compared with the crust. The decomposed matter of the surface layers sinks to the bottom, and may form there a comparatively dense deposit, but the middle layers consist of thin mud, and often contain vast quantities of

An old Pine Forest on the edge of the Atlantic; Co. Sligo. [R. WELCH, *Photo.*

water, which either descend from the surface in wet weather, or ascend from springs in the bottom of the bog. The felted crust is usually sufficiently strong to resist the pressure of the semi-fluid interior, even on large bogs which are situated on sloping ground; but exceptional circumstances may cause rupture An unusually wet season may swell the bog beyond the point of stability; or the stoppage of underground channels may cause great gatherings of water, and ultimate collapse of the crust; or turf-cutting injudiciously carried out may weaken the margin of the bog; and a bog-flow may result. These flows vary greatly in their character. The bog may slide bodily forward over its more fluid layers, so that the movement resembles a land-slide. This is, for instance, what happened in Joyce Country, Connemara, in September, 1821, when "upwards of a hundred acres of land, on which crops were growing and several families resided, were heard to emit a sound resembling thunder; the earth then became convulsed, and eventually this large tract moved down towards the sea, leaving the whole route over which it passed a complete waste."* A quaint and interesting account of a similar occurrence in Co. Limerick in 1697 may be read in the *Philosophical Transactions*†:— "On the 7th day of June, 1697, near *Charleville*, in the County of *Limerick*, in Ireland, a great Rumbling, or faint Noise, was heard in the Earth, much like unto a Sound of Thunder near spent; for a little Space the Air was somewhat troubled with little Whisking Winds, seeming to meet contrary Ways: And soon after that, to the Greater Terror and Afrightment of a great Number of Spectators, a more wonderful thing happened; for in a Bog stretching North and South, the Earth began to move, viz., Meadow and Pasture Land that lay on the Side of the Bog. . . . This Motion began about Seven of the Clock in the Evening, fluctuating in its Motion like Waves, the Pasture-Land rising very high, so that it over-run the ground beneath it, and moved upon its Surface, rowling on with great pushing violence, till it covered the Meadow, and is held to remain upon it 16 Feet. . . ."

In many other cases the bog has burst instead of slid. A few reports of such occurrences may be quoted:—

"A large bog of 1500 acres, lying between Dundrum and Cashel, in the County of Tipperary, began to be agitated in an extraordinary manner, and to the astonishment of and terror of neighbouring inhabitants. The rumbling noise from the bog gave the alarm, and on the 30th it burst, and a kind of lava issued from it . . . . overspreading and laying waste a fine tract of fertile land. . . . . Everything that opposed its course was buried in ruins. Four houses were totally destroyed, and the trees that stood near them torn up by the roots."‡ Again, "After a sudden thaw of snow, the bog between Bloomfield and Geevah [Co. Sligo] gave way; and a black deluge, carrying with it the contents of 100 acres of bog, took the direction of a small stream, and rolled on with the violence of a torrent, sweeping along heath, timber, mud and stones, and overwhelming many meadows and arable land. On passing through some boggy land, the flood swept out a wide and deep ravine, and a part of the road leading from Bloomfield to St. James's Well was completely carried away from below the foundation for the breadth of 200 yards."§ In some cases the disturbance, at least at first, was local, and clearly caused by the undue accumulation of water, presumably owing to stoppage of the ordinary drainage channels. For instance, from an account of the bursting of a bog in Co. Antrim in 1835, sent to the *Magazine of Natural History*,‖ we gather that during one day a portion of the surface of the bog swelled up till the convexity was 30 feet in height, when with a noise like a rushing wind, it sank several feet, ejecting tufts, mud, and water; two days later the same movement was repeated, and eventually a great discharge of mud and water took place. The liquidity of the discharged interior varies greatly in different cases. As we have seen from some of the quotations above, the flow sometimes assumes the form of a rapid torrent. On the other hand, in one instance a farmer, digging potatoes, looks up to discover a brown mass creeping across the field towards him.¶ And Sir William Wilde states that in the well-known bog-flow of Kilnalady, in King's County, the bog-stuff "moved down the valley at the rate of about 2 yards an hour, with a

* "Census of Ireland, 1851," Part V., Vol. I. p. 90. 1856.

† *Phil. Trans.*, Vol. XIX., pp. 714-716. 1697.

‡ *Gentleman's Magazine*, Vol. LVIII., p. 355. 1788.

§ Lyell: "Principles of Geology," 10th Ed., Vol. II., p. 504.

‖ *Mag. Nat. Hist.*, Vol. IX., pp. 251-261. 1836.

¶ Savage: "Picturesque Ireland," pp. 234, 235.

front 200 yards wide and 8 feet deep."* In both the cases last quoted the catastrophe was clearly traceable to unscientific turf-cutting. To the same cause is to be attributed the fatal bog-flow of 28th December, 1896, near Killarney, whereby Lord Kenmare's quarry steward, his wife, and six children, lost their lives, and much arable land was destroyed. The writer can speak from his own knowledge of this bog-flow, having visited the ground and prepared, in conjunction with Prof. Sollas, a report† to the Royal Dublin Society on the catastrophe. This was a large bog, 750 feet above sea-level, lying on a watershed, and draining in three directions. The rupture took place along the face of a turf-cutting, and a vast flood poured forth, overwhelming two roads and the cottage in which the unfortunate Donelly family were asleep, and rushed down the valley with diminishing violence till it reached the Lake of Killarney, fourteen miles away, in which some of Donelly's furniture was afterwards found floating. The flood continued in diminishing quantity for five days, not regularly, but intermittently, as fresh portions of the bog gave way, with loud noises, and slid into the torrent, the lighter upper crust being borne along in floes on the surface of the inky flood. Before the outburst, the surface of the bog had been convex. When the flow subsided, a valley extended from the point of collapse, over the greater portion of the bog, 7 furlongs long by 5 furlongs wide, with a maximum depth of 28 feet. As the former height of this part of the bog above the margin of the depression was some 7 feet, it follows that the total maximum subsidence amounted to 35 feet. Here, and along the centre of the new valley, the bog was completely evacuated, the white bottom gravel showing among the stranded floes of surface crust. A well-marked lip marked the margin of the disturbed area. Inside this, the crust was broken by a series of parallel crevasses, caused by the slipping in of bog, and filled with water and bog that had risen from below. These crevasses were narrow at first, becoming wider further in, till near the centre line of the flow the area of heathy surface was small compared with that of semi-liquid peat.

Calculation of the volume enclosed between the surface of the bog before and after the catastrophe showed that six million cubic yards of material had been discharged, the greater portion of it within the first few hours of the outburst. This matter consisted of water charged with bog-mud, and carrying along with it great lumps of the more solid crust of the bog, innumerable stools of Scotch Fir from the lower layers of the bog, with trunks of trees and every other movable or breakable thing that the flood encountered. As the discharge lessened, these were left stranded, and the sight of the valley filled with black slime, out of which stumps and roots protruded like wildly waving arms, and in which, no man knew where, the naked corpses of the Donelly family lay entombed, was melancholy in the extreme. The high-water mark of the flood was rendered conspicuous by the fact that there was deposited the lightest portion of the material, forming an abrupt lip two feet in thickness, which, in our report, we likened to outpoured oatmeal porridge.

It will be noted that all our examples of bog-flows have been drawn from Ireland. Ireland is, indeed, not only as regards Europe, but as regards the whole world, essentially the country both of bogs and of bog-flows. A recent estimate shows that in spite of continued reclamation, 1861 square miles, or one-seventeenth of the whole surface of the country, is under low-level peat-bogs. As regards bog-flows, Klinge,* one of the most recent investigators of the subject, after a diligent hunt through European literature, produces records of but two occurrences of the kind outside Ireland. To these, Prof. Sollas and the writer have added but two others; these four are located, one in England (Solway Moss), one in Germany (Treuenfeld, Oldenburg), and two in the Falkland Islands, off Cape Horn. In Ireland bog-flows are of comparatively frequent occurrence. Seventeen are listed in the report on the Kerry flow, already referred to, and many have passed unrecorded.

* "Census of Ireland, 1851," Part V., Vol. I., p. 189. 1856.

† *Sci. Proc.* R.D.S., Vol. VIII., N.S., Part 5. 1897.

* Ueber Moorausbrüche. *Bot. Jahrbücher*, Bd. XIV., p. 426. 1892.

DR. AITKEN ON SUNSHINE AND CLOUDY CONDENSATION.

By Dr. J. G. McPherson, F.R.S.E.

Although no man has wrought so hard as Dr. Aitken to establish the principle that clouds are mainly due to the existence of dust-particles which attract moisture on certain conditions, yet even twenty years ago he said that it was probable that sunshine might cause the formation of nuclei, and allow cloudy condensation to take place where there was no dust.

Robert von Helmhotz and Professor Richarz, in their very beautiful experiments made with the steam jet, endeavoured to show that cloudy condensation was due to the molecular shock produced by the chemical processes going on in the neighbourhood of the jet. This theory Dr. Aitken has ingeniously exploded in his communication to the Royal Society of Edinburgh. He says: "Supposing we even admit that a molecular shock of the kind could determine condensation in a supersaturated vapour, it must be remembered that the degree of supersaturation in a steam jet in the open air where there is dust is extremely slight—the particles of water are so close that any strain easily relieves itself. Further, it must be remembered that the vapour in the jet is nearly in equilibrium with the drops of the size present in the jet."

There must, therefore, be some other means of accounting for cloudy condensation, in cases where there is no dust. Under certain conditions the sun gives rise to a great increase in the number of nuclei. Accordingly, Dr. Aitken has carefully tested a few of the ordinary constituents and impurities in our atmosphere to see if sunshine acted on them in such a way as to make them probable formers of cloud-particles.

He tested various gases, with more or less success; and he has communicated his results to the Society. He found that ordinary air, after being deprived of its dust-particles, and exposed to sunshine, does not show any cloudy condensation on expansion, but when certain gases are in the air a very different result is obtained.

He first used ammonia, putting one drop into six cubic inches of water in a flask and sunning this for one minute; the result was a considerable quantity of condensation even with such a weak solution. When the flask was exposed for five minutes the condensation by the action of the sunshine was made more dense. Though double the quantity of nitric acid was put into six cubic inches of water, the condensation was not so dense.

Hydrogen peroxide was tested by Dr. Aitken in the same way, and it was found to be a powerful generator of nuclei. Curious is it that sulphurous acid is puzzling to the experimentalist for cloud formation. It gives rise to condensation in the dark. On some days it was impossible to get the condensation to cease entirely. But sunshine very conclusively increased the condensation.

Sulphuretted hydrogen, which one always associates with the smell of rotten eggs, gave dense condensation after being exposed to sunshine. Chlorine was one of the most interesting of the gases tested by Dr. Aitken, as it caused condensation to take place without supersaturation.

In his investigations, Dr. Aitken considered how long these nuclei, due to the action of sunshine in certain gases, would remain active for cloudy condensation. But he is not yet prepared with very satisfactory results. Some are very short-lived—fifteen minutes to half-an-hour being sufficient for the diluted hydrogen peroxide in the flask to lose its power of cloudy condensation; while the nuclei from sulphurous acid remained active for a considerable time.

He is now convinced that it is possible for cloudy condensation to take place in certain circumstances in the absence of dust. This seems paradoxical when we remember Dr. Aitken's beautiful experiments twenty years ago; but in ordinary circumstances dust is needed for cloud formation. However, supposing there is any part of the upper air free from dust, it is now found possible, if any of the gases experimented on be present, for the sun to convert them into nuclei of condensation, and permit of clouds forming in dustless air, miles above our atmosphere.

In the lower atmosphere there are always plenty of dust-particles to form cloudy condensation, whether the sun shines or not. But in the higher atmosphere, and in the region above our atmosphere, clouds can be formed by the action of the sun's rays on certain gases. This is a great boon to us on the earth, for it assures us of clouds to defend us from the sun's extra powerful rays, even when our atmosphere is fairly clear. Dr. Aitken's communication is of some meteorological importance; but he is cautious, and we wait for his more matured conclusions.

ASTRONOMY WITHOUT A TELESCOPE.

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

XIX.—THE COLOURS OF STARS.

In concluding my review of departments of observation open to the "astronomer without a telescope," I wish to glance at one which offers him some small opportunity, although in general it must be considered one for the possessors of telescopes and those even of considerable size.

The wide difference which there is between star and star as to brightness is apparent on the very first glance towards the heavens; it requires a more careful scrutiny to realize that they differ also in their colour and in the character of their shining. The ancients carried their discrimination of the difference in the brightnesses of stars so far as to recognise six magnitudes, and added the further refinement that they noted many stars as being somewhat brighter or somewhat fainter, as the case might be, than the average star of their magnitude, but when it came to the question of colour they hardly noted any differences at all. The stars in general were described as yellow, six only being recorded as "fiery." Of these six we should class five as being distinctly orange or red—Antares, Betelgeuse, Aldebaran, Arcturus and Pollux. The sixth, Sirius, is to us an intensely white star, and there have been many discussions as to whether it has changed its colour in the last 2000 years, or whether the description given of it—"fiery red"—is due to some mistake in the record, or whether the excessive scintillation of the star may account for it. For, as we see it now when near the horizon, a momentary flash of vivid red flames out from time to time, due to the irregular dispersion of its light in passing through the tremulous atmosphere. It is from this that Tennyson, most exact of all the poets in his scientific references, calls Sirius "fiery" in the well-known passage from the "Princess":—

> "The fiery Sirius alters hue
> And bickers into red and emerald."

A careful comparison of star with star will soon show that this classification is far from exhausting the differences of tint which may be recognised amongst the stars visible to the naked eye. Indeed the Star Colour Section of the British Astronomical Association, under the able and energetic direction of Mr. W. S. Franks, F.R.A.S., some few years ago drew up a catalogue of all the stars of the fifth magnitude and brighter, and recognised no fewer than twenty different tints or shades. The immense majority were indeed white, or white with a more or less evident tinge of yellow, up to a fairly full yellow, and the observations were made for the most part by means of refractors of three to four inches in aperture, or of reflectors of six to eight inches. The observer, therefore, who has no telescope, or who at best possesses but a good field-glass, would neither be able to deal with stars so faint as the fifth magnitude, nor to detect as many differences of colour.

Nevertheless, with a good field-glass some three hundred stars would be within his reach, and with the naked eye alone quite one hundred, the colour of which he might successfully estimate, and in all probability with patience and experience he would succeed in grouping these into fully a dozen different categories. The work would soon be felt to be an attractive one, for delicacy of discrimination would be sure to come with practice; and the sense of the power to discriminate with quickness and certainty between two stars which at first glance showed no difference would certainly bring pleasure.

In the work of estimating the colours of stars, there are two different points to keep in mind. The one is, what point in the spectrum should be taken as best representing the dominant tint of the star. The other, what is the intensity of that tint, for it must be remembered that the stars give continuous spectra, that is to say, the groundwork of their spectra is essentially continuous. Roughly speaking they all give light of all wave-lengths; in other words, they shine essentially by white light. We have no stars with spectra limited to one particular region. Even in the banded spectra none of the seven colours that we ordinarily recognise are entirely wanting, and even if we went further, as we easily might, and divided the spectrum not into seven only, but into twelve or more different colours the same statement might hold good.

We must therefore regard the stars as shining essentially by white light. But the various tints which together go to make up a perfect white, are not always found in their exact proportion. We may regard, therefore, a coloured star as a star shining by white light plus a certain proportion of light of one or more specific colours.

Assuming that this is so, that the light of any star is partly white and partly coloured, we may divide the stars into classes, depending entirely upon the depth of tint which they show, and not upon its colour. A five-fold division suggests itself, something to the following effect:—(1) pure white, (2) tinted, (3) coloured, (4) fully coloured, (5) deeply coloured. Amongst the stars visible to the naked eye the full and deep colours are rare; it is especially in the field of double star astronomy that we get the deeper and richer tints.

After the question of the depth of tint which the stars show, comes the question of the colour of that tint. For naked-eye stars, the more refrangible colours do not come into consideration. The range is from orange-red up to yellowish green, or possibly in a single instance—that of Beta Libræ—to green. Alpha Lyræ, and possibly one or two other stars, have a distinct bluish tinge, but in general the stars not passed as white may be very well scheduled under one of the five following heads:—(1) reddish-orange, (2) orange, (3) orange-yellow, (4) yellow, (5) yellowish green.

In working upon star colours with the field-glass or naked eye it is impossible to use any artificial standard of colour, but the wide field of view, and the ease and rapidity with which the attention can be turned from one part of the heavens to the other, will much more than make up for this deficiency. The stars must be compared one with another, and the estimations of colour must be purely relative, and the method will be found much the most accurate possible.

The most satisfactory programme for an evening's work would probably be to take a number of stars not differing too widely in magnitude, and without regard to the exact name to be given to the depth of tint of each, to arrange them simply in order of colour intensity, beginning with the star of purest whiteness and going downwards to the one that showed the fullest tint. It would probably be found well for the sake of simplicity to keep this work of the arrangement in order of the depth of tint entirely separate from the work of arrangement in order of colour. For several nights a large number of stars should be taken and carefully compared, each one with the others, until a satisfactory progression has been arranged for the whole number; the depth of tint being the criterion. Then, when this work has been carried out successfully, a similar comparison should be instituted as to the colour of the stars, ranging them in order from the reddest to those which show the nearest approach to green; and in this second comparison it would probably be found useful to confine the work at first only to the stars of deep tint, then to those of full colour, and so on, until last of all those are classified according to the spectral order of their colours which are only slightly tinted. Thus, if a hundred stars have been selected as showing some more or less appreciable tint, and have been arranged in order of the depth of tint, number 100 being the star of deepest tint, then numbers 61 to 100 might be the subject of the first arrangement in spectrum order, numbers 41 to 80 of the second, and so on.

The great advantage of making the colour estimations purely comparative would be that in the case of any variation of colour in any star its detection would be easier, and much more free from ambiguity than by any other method. Thus Klein and Weber state that Alpha Ursæ Majoris passes through a series of colour changes in a period of 33 days. Several telescopic stars are supposed in like manner to have changed their colour. The case of Sirius has already been referred to, but whatever it may have been in classical times, it certainly has shown itself unvarying white in our own day. Algol, also a white star to us, is described by Al Sufi as "red." It is therefore not impossible that the systematic study of star colours, even though it be undertaken by the naked eye alone, or at best with the assistance of a field-glass, may yet succeed in discovering an instance of colour change. But should it fail to do so, it must not be forgotten that the clear and unmistakable evidence, which a thorough and systematic record of the relative colours of stars would supply, that no colour change had occurred, would be just as valuable, just as important.

Closely connected with the colour of stars is their mode of shining; in other words, their scintillation. The blue stars and white stars, like Vega and Sirius, "twinkle" the most rapidly; the orange stars shining the most steadily. The planets ordinarily do not scintillate. This scintillation is, of course, due to tremors in our own atmosphere, since the stars are to us absolutely mathematical points to which not even the most powerful telescope has yet succeeded in giving any appreciable diameter. It follows that when the air through which the star's rays pass to our eye is in great agitation, many rays may reach us one moment and few the next, and the star may seem to flicker like a candle in the wind. The planets do not scintillate because they show to us real disks, even though these are not large enough to be perceived as such by the naked eye. The one exception, the planet Mercury, is an exception partly because it is always near the horizon when seen with the naked eye, and partly because its diameter is very small. It owes its Greek epithet στιλβων, "glittering" or "flashing," to this peculiarity amongst the older planets.

The measurement of the amount, or, rather, rapidity of scintillation, lies beyond the power of the "astronomer without a telescope," but even to the naked eye there is a marked difference in this respect between star and star, and the observer will not be able to overlook its evident connection with the star's colour.

The review of the various departments of observation, available to the unassisted sight, has thus brought us to studies, as in the case of variable stars and star colours, where, though there is a certain amount of work to be done without optical aid, yet the observer's field is much increased by the possession of a good opera-glass or field-glass.

We have come as it were to the threshold of that noble structure which has been built up by means of the telescope and spectroscope; but to that building there are many guides, and to explore it lies beyond my present task. The purpose which I have set before myself has been a much humbler one, but if I have succeeded in arousing interest in those astronomical phenomena which require no "optic glass" for their display, I shall be well rewarded.

And I think that he who seriously undertakes some department of astronomy without a telescope, will likewise not fail of his reward. The growth in the power of perception which careful practice in observation brings is a real gain. Real too is the gain in habits of system and method. For to perceive is but a part of the astronomer's work; he must learn to record what he has perceived, and must form the habit of recording at once and recording in order. And this habit, as well as the gain in perception, means increase of power, and power gives pleasure. Pleasure there is too in gaining as it were from direct converse with nature, fresh insight into her mysteries; pleasure, if our knowledge is really increased; pleasure, too, even if the problems prove too involved for us and our only progress be towards a truer appreciation of their difficulty.

The fields of work which we have passed in review have been both many and varied. They have extended from phenomena the most slight and transient—the lighting of a sunset cloud, the momentary flash of a meteor—to the greatest and most enduring that the universe can show—the fabric of the Galaxy and its interweaving with the stars. And there is above all in this direct study of the heavens, out in the open, beneath the deep unsounded sky, a charm and an awe, not to be realised otherwise. It is nature at her vastest that we approach; we look up to her in her most exalted form. We see unrolled before us the volume which the finger of God has written; we stand in the dwelling-place of the Most High.

NEBULÆ INDEX CATALOGUE 1318 CYGNI.

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

S

P.

F.

N.

PHOTOGRAPH OF THE NEBULOUS REGION ON THE FOLLOWING SIDE OF GAMMA CYGNI.

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

The photograph annexed is of the region of the sky comprised between R.A. 20h. 20m. 25s. and R.A. 20h. 26m 50s., and in Declination between south +39° 12′·0 and +40° 48′·5 north. The area, therefore, is 6m. 25s. in extent from *following* to *preceding* and 1° 36′·5 from north to south. Scale—one millimètre to twenty-four seconds of arc.

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

Star (.) D.M. No. 4178. Zone +39° R.A. 20h. 21m. 51·5s. Dec. +39° 27′·9. Mag. 7·5.
Star (.) D.M. No. 4193. Zone +39° R.A. 20h. 23m. 7·6s. Dec. +40° 1′·0. Mag. 7·7.
Star (.:) D.M. No. 4188. Zone +40° R.A. 20h. 24m. 58·2s. Dec. +40° 34′·1. Mag. 8·0.

The photograph was taken with the 20-inch reflector, and exposure of the plate during 90 minutes on the 5th September, 1901, and, like the many other nebulæ which I have photographed during the past fifteen years (some of which have been published in Knowledge and in my two volumes of *Stars, Star-Clusters and Nebulæ*), it presents characteristic features of aggregation into definite *loci* which will probably develop into separate nebulæ; some of them assuming, under the stress of disturbance and gravitation, the form of spiral nebulæ; these again will develop into stars and clusters of stars.

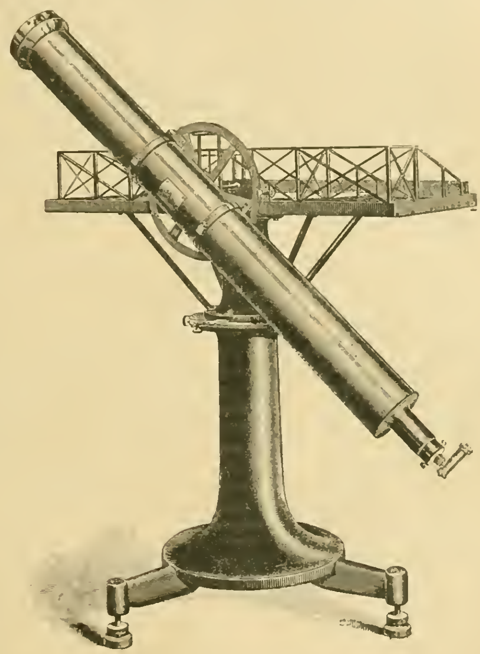
In this manner does the evidence, which has been accumulated by the aid of photography and by eye observations, lead us to the inference that changes—eternal changes—are part of the order of Nature, whether we view them in the inconceivable distance of space amongst the stars and nebulæ, or in the smallest microscopic compound or organism on this relatively small speck of earth. The results are consistently identical in principle, that the older forms of matter are disintegrated and afterwards reconstituted into new forms of aggregated matter and of life. This appears to be invariably the grand order of the laws of Nature.

THE DURHAM ALMUCANTAR.

By Prof. R. A. Sampson, m.a.

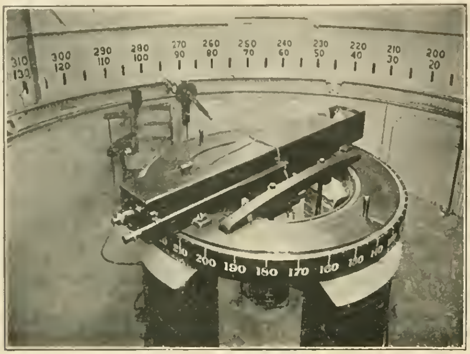
In the problem of mapping and measuring the skies, general attention has of late years been directed mainly to the work that can be done with a photographic equatorial, that is to say, to the task of completing the astrographic plates, and of devising satisfactory methods of measuring and recording them. But at least among those professionally engaged in astronomy this is not due to any neglect of another and more fundamental branch with which the equatorial cannot compete. One recalls that Bessel gave the name *Fundamenta Astronomiae pro anno* MDCCLV. to his discussion of Bradley's transit results. For the measurement of large distances upon the sky and fixing all the critical points, the transit circle and clock have hitherto been the sole authorities. Now, no matter how good a method may be, it is always preferable to check its results by a different method than to repeat them. Take what precaution we may, each system almost certainly brings with it its own systematic faults, which it is next to impossible to eliminate; hence there is very great importance attaching to a radical variation of the design of instrument and system of observation of transit work. The transit circle has held its own in the past against more than one such rival. The two altazimuths at Greenwich occur to us at once as instances. A variation of the traditional design of transit circle was suggested by the late Mr. E. J. Stone in 1881, in which there was no tube at right angles to the conical axis about which the instrument revolved, but in the centre of this axis the light fell upon a prism which diverted the rays so that the eye looked through this axis when observing, and the third face of the prism was curved to give the necessary deviation to the rays. This instrument was never made. Up to the present time, the undivided credit of inventing and using an instrument and method which are exact enough to check if not to outdo the determinations of the best transit circles belongs to Mr. S. C. Chandler, of Boston, U.S.A.

"The idea occurred to me about eight years ago," Mr. Chandler writes in 1887, "of substituting for the meridian as a fundamental plane of reference, the small circle



Chandler's Almucantar.

perpendicular to the meridian passing through the pole; and for the motion of rotation determined mechanically by the pivots of a horizontal axis, one determined by gravitative action about an imaginary vertical axis. Two ways of doing this suggested themselves. The instrument might be suspended like a pendulum, or it might be floated upon mercury." Experiments decided in favour of the latter method, and after making a small trial instrument and obtaining from it results of unexpected accuracy, Mr. Chandler, in the years 1884 and 1885, used facilities placed at his disposal by the director of Harvard College Observatory to make a more searching study of the possibilities of his invention. In this research he employed a new instrument, with a telescope of 4 inches aperture. It was mounted on a tripod stand, which carried a horizontal trough which could rotate in azimuth; this trough contained mercury, and in it rested a float which carried the telescope. The float was held in place by pins running in slots, which were intended to allow the float to level itself in the mercury, while forbidding motion in azimuth. An axis held the telescope beyond the float clear of the trough, so that it could be clamped at any



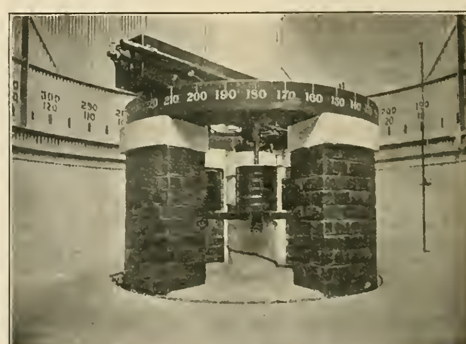
The Case College Almucantar.

altitude. This instrument Mr. Chandler called an "almucantar." The term "almucantar" has almost gone out of use in recent books, but in older ones we find it. For instance, Delambre gives "*Almicantarat*, terme arabe; c'est un petit cercle parallèle à l'horizon, et dont les pôles sont le zénit et le nadir." It is clear that the optic axis of the instrument described above, when clamped in altitude and moved in azimuth, traces out a horizontal circle upon the sky, and the accuracy with which it does so depends only upon the accuracy with which the floating parts regain their old orientation with respect to the vertical, after the disturbance that occurs when the azimuth is changed.

In actual use the altitude is always such that the centre of the field passes through the pole, or rather differs from it by a small collimation constant, which is determined afresh each night. Spider lines are placed horizontally at the eye-end, and the co-ordinates of a star are found by two time observations of its transits east and west of the meridian as it is carried across the circle of observation by the earth's rotation. Azimuth is used only for the purposes of setting, and does not appear in the result.

Mr. Chandler's observations, of the merits of which I shall speak later, were discontinued in 1885, and found no one to carry them on till the year 1900. In that year, in the month of February, the Durham almucantar was set up, and in March Prof. C. S. Howe erected one at Case College, Cleveland, Ohio. I give figures of each of these instruments, for their differences illustrate well the flexibility of the design. The Durham almucantar and that of Case College are each of six inches aperture, that is to say, of as great power as any transit circles, excepting one or two of the largest. In both the telescope axis is horizontal, the view of the skies being gained by the intervention of a plane mirror; in both the trough and float are made of cast iron, and allow about the same margin of mercury at the sides. Beyond this we might almost say that if two instruments had been designed by the same man to experiment upon the different ways of doing the same thing, they could not have served that purpose better, and we may expect interesting results as to which form is preferable from the comparison of the Durham results with those of Prof. Howe. In the Durham instrument the mirror is behind the object-glass, and different altitudes are secured by rotating the telescope tube in Y's; in the other the mirror is exposed, and is itself in slight degree adjustable. In the former the trough is rectangular, with sides about 2 feet by 3 feet and about 2 inches deep, and forms part of a large table which turns about a vertical axis, carrying the floating parts with it, which are fixed relatively to it by means of brackets which bear against agate plates on the outside of the trough. In the latter the trough is ring-shaped, about 5 feet external diameter and $4\frac{1}{2}$ inches deep, and is fixed to the piers, the telescope and float turning in the trough, and guided in their motions by a pin at the centre working in oil. In the former the clamp and slow motion work upon the edge of the rotating table; in the latter they work upon an arm projecting from below the centre of the telescope, and designed so as to limit only the azimuth, and not at all the orientation of the floating parts with respect to the vertical. In both telescopes there is little doubt that this essential and that of rapid subsidence of oscillations after setting are fully secured. Without criticising Prof. Howe's design, I have found the rotating table in my own of the utmost convenience. I have now built up upon it a wind screen, which is designed to cover in entirely the floating parts. It will be seen in the plate that a long arm runs out from it, carrying an eye-guard; since the photograph was taken this has been removed, and the arm now carries the eye-piece itself with a sliding arrangement, so that the eye-piece is actually detached from the telescope. As to the success of this arrangement I was not very confident in advance, but it was necessary to try it, because oblique transits carry the star across the wires at the limits of the field. Happily it turned out a thorough success.

Now making a comparison of transit circle and almucantar in respect to their observations, there can be no doubt that although the almucantar is disturbed by each fresh setting, when the oscillations have subsided it



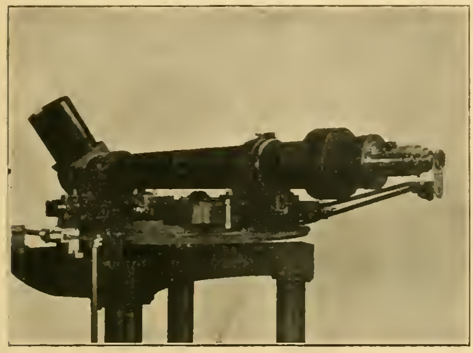
The Case College Almucantar.

resumes its old orientation to the vertical within perfectly insensible limits. The effect of this is the same as if in the transit circle we could write the errors of azimuth and level permanently at zero.

The corrections for refraction are immensely reduced, since observations are all made at the same zenith distance.

That for flexure of the telescope tube is abolished. The observer takes a natural attitude, the same for all stars, in place of inverting himself upon the usual observing couch. These are some of the advantages of allowing the axis of rotation to be determined by gravity and not by the instrument maker.

Of course the advantages are not all on one side. The transit circle can take every star that is visible; for the almucantar we draw a ring upon the sky, passing horizontally through the pole, and disregard all that is not carried across it; at Durham this limits us to stars not



The Durham Almucantar.

more than 70° from the pole; a more southerly latitude would be better, but, as we cannot change the latitude, we must be content that there is more work within reach than we can ever do. A complaint that will require more investigation is that the stars cross the wires obliquely. Each star cuts the wires at an angle equal to its hour angle at the time of transit, thus varying for different stars from a right angle at the pole to zero at the southern limit. As a consequence a change of declination produces more effect upon the transit of a southern star than upon one more northerly; and declinations are better determined for the former than the latter. Declination should be very well determined at the lower range of the instrument, for all the measures are absolute measures from the pole, not as in the transit circle, measures made by reference to a divided circle and some reflecting apparatus.

As to the calculations involved, I believe that when large numbers of stars are discussed the advantage lies with the almucantar.

Exactly what an almucantar observation gives may be shown by a diagram. The difference is observed between the times which we could predict for the star's passage, according to the *Nautical Almanac*, and the time at which it actually appears. This difference has to be shared in proper proportions between corrections to the latitude, if erroneous, to the clock, to the zenith distance of the telescopic axis, and to the co-ordinates of the star, for each of these contributes a share. The diagram below shows the amount of error in latitude, zenith setting, or declination which would contribute an error of $0^{s}{\cdot}1$ in a transit, and inversely it shows how accurately we may expect to determine these quantities by sifting them out from the inevitable errors of observation. The fact that all these unknown corrections are mingled together in a single statement of difference between observed and predicted times is no disadvantage. On the contrary, it is a positive gain; for it permits the ready application of the rule known as "Least Squares" for combining a set of observations to the best advantage so as to derive clock correction and the rest from them. At the same time, as everything is got out of the observation itself, the observer is relieved from vexatious supplementary measures of faults of adjustment of his instrument.

Dr. Chandler observed for thirteen months or sixty-three nights in all. If the almucantar is to be a serious rival of the transit circle, such a series is not large enough to do it justice. Such a series, dating from when the instrument was first set up, might be expected to make out a *primâ facie* case, and point out promising lines of investigation. That it did this and more does not admit of question. It was confined to observations of stars in the catalogue of the *Berliner Jahrbuch*, and as these are very well observed stars, a rough and ready test of Dr. Chandler's success is to take the residuals which are to give corrections to co-ordinates of the stars, and see whether these depart much from zero. The first twenty stars upon his list which are not close to the limits of his range give thus $\pm 0^{s}{\cdot}086$; if stars about 70° declination be omitted it becomes $\pm 0^{s}{\cdot}066$. We may put this in the form, that a single observation used to determine right ascension would, on the average, depart so much from the truth, and this is based upon assuming that the *Berliner Jahrbuch's* places require no correction at all. If we make those allowances for a new instrument which anyone's experience will suggest—but which, be it remarked, Dr. Chandler himself does not claim—it is out of reason to expect anything finer.

But that the almucantar will do even better I believe we have already proved at Durham, though we have only emerged some two or three months from the difficulties of a start; in evidence of this I quote below the results of the last night's observations that have been fully reduced,* 1901, November 15. E. or W. attached to a star indicates

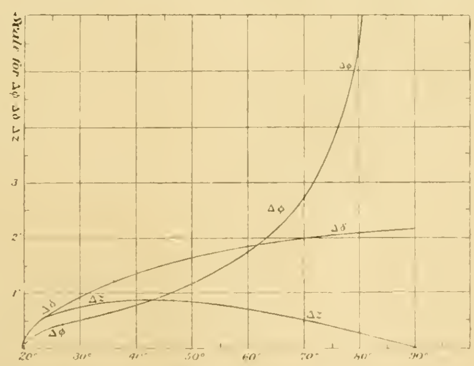


Chart of Almucantar Constants for Latitude of Durham Observatory (54° 46′ 6″·2 N).

Abscissa = declination of object.

Ordinates:—$\Delta\delta$ = error in deduced declination for $0^{s}{\cdot}1$ error in transit.
$\Delta\phi$ = " " latitude " " "
Δz = " " collimation " " "

the side of the meridian on which the transit was taken, and the fractions of a second opposite to it correspond to the numbers of which I have given the mean in Dr. Chandler's observations.

* This was written in January last.

	s.		s.
β Draconis, W.	−0·03	η Aurigæ, E.	−0·02
α Lyræ, W.	−0·07	γ Persei, E.	0·00
τ Pegasi, E.	−0·10	β Trianguli, E.	+0·02
ι Draconis W.	+0·09	Andromedæ, W.	−0·05
δ Andromedæ, E.	−0·03	β Pegasi, W.	+0·29
ε Andromedæ, E.	−0·08	ζ Persei, E.	−0·02
ε Ursæ Minoris, W.	+0·26	ε Aurigæ, E.	+0·15
32 Vulpeculæ, W.	+0·05	α Aurigæ, E.	+0·01
16 Pegasi, W.	0·00	α Cephei, W.	+0·05
β Persei, E.	+0·03	ζ Cygni, W.	−0·02

I put these numbers forward merely to give my readers a general idea of what we can do with the Durham almucantar. I do not wish at present to base any statement upon them as to the relative merits of the almucantar and the best transit circles; that must wait until observations have accumulated, and until some refinements of correction have been applied to them which were neglected in these first reductions. But in any case it is evident that an instrument that can do work like this at the very beginning of its use cannot be disregarded as a rival, no matter what other claimants are in the field.

THE CANALS OF MARS.

By B. W. Lane.

The object of this paper is to describe a series of experiments which some friends and I have been performing with a view to the settlement of this matter. The results appear to me to offer a complete explanation of these appearances.

While reading M. Antoniadi's article on "Mars" in the April number of Knowledge, I was particularly struck by his statement that only one or two of the canals were ever seen at one time (I use the terms "canal," "sea," "gulf," &c., for convenience only). From this arose the idea that possibly the atmospheric vibrations might cause such an apparent lengthening of the gulfs on the planet as to suggest the canal sufficiently to make it visible in flashes. I accordingly determined to test the matter by means of hot air currents, and a drawing of the planet without any canals marked upon it, viewed by means of a telescope.

As a sort of chance, however, I made a blank drawing of the planet like Fig. 1, and placed it at a distance of ten feet from a friend of mine, and asked her to draw what she saw. As I say, it was only a chance experiment, and I did not expect any results, and was astonished when, after first saying (after drawing in the seas) that she could see nothing more, and then, gazing awhile, she drew in two lines resembling in general character those seen on the actual planet. The positions, however, were different from those given by Schiaparelli.

The original blank drawing, however, was slightly inaccurate, so, having made another as accurate as I could, copied from one of Schiaparelli's, I tried the experiment with the improved drawing on another lady. This time I drew the seas in roughly for her, and left her only to fill in anything else she could see. I was very careful not to suggest lines to her, in fact, to make certain, I mentioned spots and shading as the things to be looked for. In spite of this, however, after ten minutes' work she had produced—*copied off this blank drawing*—a drawing in all essential respects like Fig. 3. Fig. 3 is as accurate a copy as I could make from hers. Fig. 2 is Schiaparelli's drawing of the same region, with the canals inserted. It will be at once seen by comparison that the system produced by this optical delusion is precisely similar to that seen on the surface of Mars.

I have since experimented with two boys, both aged eleven years, who had never in their lives heard of either Mars or the canals. Their attempts are reproduced in Figs. 4 and 5. Again it will be seen that, with the exception of one canal in each drawing, they are all in the same positions as those of Schiaparelli.

Altogether I have experimented with five persons, of whom one only failed to see the canals on the blank

Fig. 1.

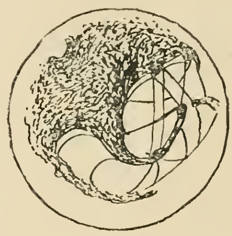


Fig. 2.

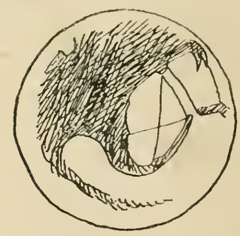


Fig. 3.

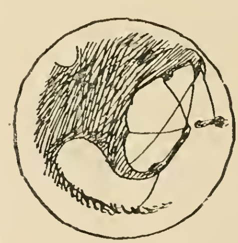


Fig. 5.

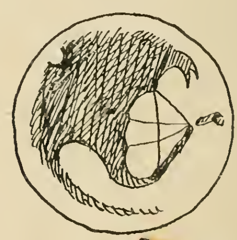


Fig. 4.

drawing. One of the boys refused to believe that the drawing I showed him was the same as that from which he had copied the lines, so certain was he that they had been actual realities. Two acquaintances of mine have both been instituting similar experiments and have arrived at identically the same results. Thus it appears probable that the mere shape of the oceans of Mars is sufficient to give rise to the appearance of the complicated system discovered by Schiaparelli.

As well as setting other people to do it, I have myself been mapping out the canals which I could see on this drawing. I do not give my map because it is identical with Fig. 2 except for about three minor lines. I have frequently seen these pseudo-canals doubled, and, when my eyes have been in the best condition, have seen not two canals only, but four or five at a time, and have sometimes seen one or more canals so firmly marked that I have had to go up to the drawing to make sure in my own mind that I had not put a line there by mistake. When first looked for, very steady gazing is needed to see them at all; in fact, in my case it required two minutes staring before I could perceive the slightest fleeting indication. If another attempt be made, say next day, they are seen much more easily than at the first attempt, and the task of seeing them becomes easier every time, until now with me I can scarcely look at the drawing *without* seeing some one or two. The first time these canals are seen they appear as broad, misty, ill-defined bands, which easily change their places, but when a little practice has been had in seeing them they appear as firm hard lines, indeed, as Mr. Lowell puts it in speaking of the real canals, "like a steel engraving." In fact, I should say from what I have been able to gather respecting the appearance of the canals on the planet, it is easier to see canals on a blank drawing like Fig. I placed at a distance of 20 feet from the eye than to see them on Mars.

The above-described experiment can be performed by anyone having a blacklead and a piece of ordinary *rough* drawing paper. It must not be expected that everyone will be able to see these canals on the drawing, since everyone who has looked for them has not seen them on the planet, but two at least out of every three persons should be able to see them with steady gazing, if the diagram is of suitable size and placed at a suitable distance. The one used by me was $3\frac{1}{2}$ inches in diameter, and was placed at a distance of 20 feet in not too good a light.

It may be said that even though the ordinary canals could be produced by an optical delusion, such a complicated system as that of Elysium could not be the product of such a cause. All that is needed to produce an exact replica of this district is that an oval patch of the drawing should be made slightly lighter in colour than the surrounding paper, when contrast will at once cause the appearance of a circular canal surrounding it, from which the other canals branch. The side of the planet pictured in these drawings is not the only one which I have made use of. In fact experiments made with drawings of the other side were even more successful, and the *netteté* of the canal known as the Hydraotes was at times truly startling.

It thus appears possible, since two systems may be seen, one on Mars, and the other on a drawing, which are not only analogous but identical in every particular (since any two observers differ as much as the drawings herewith reproduced), one of which is certainly produced by an optical delusion, that the other, viz., that seen on Mars, may also be due to the same cause. The facts that the canals are not best seen when the planet is nearest, and that canals have been seen on other planets, seem to point in the same direction. The fact that the directions of the canals change with the Martian seasons need be no hindrance to the theory of their optical production, since if they are so produced their direction and degrees of visibility depend on the shape of the Martian oceans, and since these change with the seasons, the canals will change also. It may be remarked that by not suggesting canals to the subjects of our experiments, we have put them in a more disadvantageous position for seeing them than anyone besides Schiaparelli has been in, since later observers not only heard of the canals but studied Schiaparelli's maps, and so aided any optical delusion which might exist. The above results, therefore, would have been fairly conclusive even if canals *had* been suggested.

Thus it would appear that those gentlemen who have seen the canals have, with the best intentions, been deceived by a most peculiar and almost incredible optical delusion—a delusion which has given rise to a system so complicated that no one has hitherto attempted to prove that the whole appearance was from beginning to end attributable to this cause, although many have asserted that such was the case.

[The first suggestion of the idea thus worked out by Mr. Lane occurred to me in 1882, when I noted how many of the Schiaparellian canals were prolongations of what other observers had drawn as indentations on the coast lines of Mars ("Observatory," Vol. V., pp. 136, 138). Later, in 1894, I made some experiments on the limits of visibility for dark markings on a bright background (Knowledge, 1894, November, p. 249), and incidentally noted, when irregular forms were at such a distance that the minutest details of their irregularities were too small to be separately defined, and yet were large enough to produce some impression, that it was easy to interpret such irregularities as parts of a network of straight lines. I further noted that under such circumstances, *i.e.*, when markings were too narrow or too small to be fully and distinctly defined, but yet were sufficiently large to be indefinitely glimpsed, the rendering in the case of narrow markings, however winding, broken or irregular, was that of straight lines; but in the case of compacter objects the rendering was of round dots. And narrower objects could be discerned as straight lines than as dots. Hence I ventured to foretell (Knowledge, 1894, November, p. 252) that the Schiaparellian canal system would be followed by the discovery of a system of "lakes"; a prophecy almost immediately fulfilled at the Lowell Observatory, by the detection of the "oases."

Acting on the suggestion of Mr. Lane's letter, and by the kind co-operation of Mr. J. E. Evans, headmaster of the Royal Hospital School, Greenwich, I have quite recently subjected a number of drawings of Mars—free from canals—to boys in that school, for them to copy. The result was striking. Four out of five drew no canals, but the remaining fifth supplied them. And it was clear that this was directly a question of their distance from the drawing. Boys near the drawing saw too well and distinctly to imagine spurious lines. Boys at a great distance could only perceive the leading features of the drawing. But those at mean distance, by whom the minor details were imperfectly perceived, in many cases rendered these by straight narrow "canals."

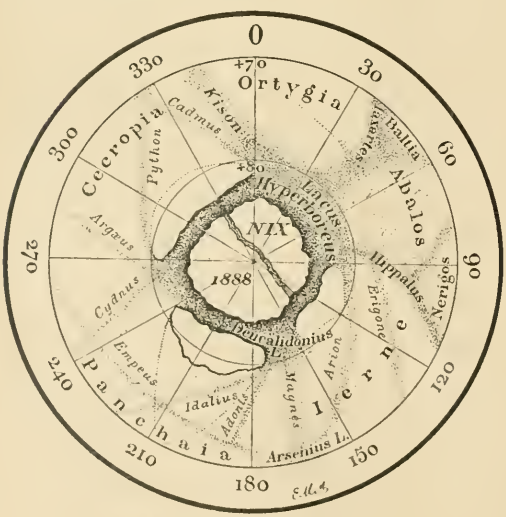
Yet I am not prepared to accept Mr. Lane's conclusion quite as he puts it. Some of the "canals" seem to have been detected with so low a power that their full and distinct definition would be well within the power of large and well-placed telescopes. Hence my own view of the "rendering" or "interpretation" of undefined objects would not enter into their case. Nor do my own experiments quite confirm his as to the canals presenting themselves to the imagination, unless there are minute markings present—however unlike the canals—to afford a sort of basis for them. *E.g.*, stippling lightly the general surface, but leaving Elysium free, was quite enough to create a polygonal system of canals around Elysium. But though the stipple dots were too small to have been separately and clearly seen at one-twentieth the distance, they or their equivalent had to be present, or no "canals" would have been seen.

Nevertheless, Mr. Lane's letter puts in a new and striking light a factor in the problem of Mars which, although almost entirely neglected hitherto, will have to be taken into full account in the future.—E. Walter Maunder.]

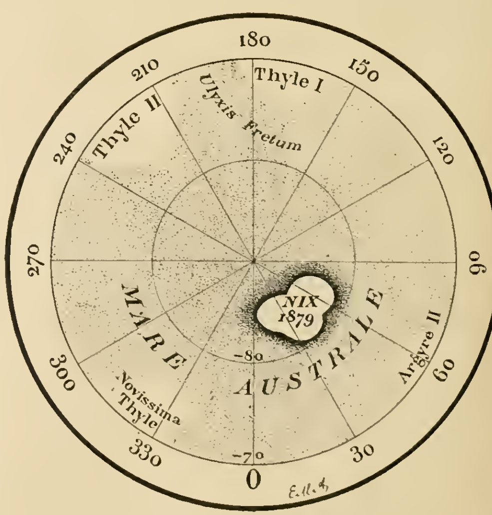
CHART OF MARS.

By E. M. ANTONIADI, F.R.A.S.

THE kindness of Monsieur E. M. Antoniadi enables us to meet the wishes of several of our correspondents who have asked for a chart of Mars brought up to date, and embodying the most trustworthy researches. The chart is based chiefly upon the works of Schiaparelli during the oppositions of from 1887 to 1890 inclusive, and upon the successive Reports of the Mars Section of the British Astronomical Association, together with M. Antoniadi's own long-continued observations.



North Polar Region of Mars.



South Polar Region of Mars.

Letters.

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

PERRINE'S COMET.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The enclosed photograph of Perrine's comet was obtained with a 4½-inch double combination Voigtländer of 15 inches focus, on 2nd October, at 9h. 50m. (mean) S. T., the exposure being for 30 minutes.

Cadett lightning plate with pyro metol developer was used, and the camera was attached to a 6¼-inch equatorial reflector, clock-driven.

Owing to the faintness of the nucleus, illumination of the field was impossible, so that the comet could not be followed, but the driving had to be done upon δ Cephei, which was then a little *n. p.* the comet.

N

On the negative there are symptoms of a divided or fan-like tail, a feature which would be obscured to a great extent by the actual motion of the comet.

Owing to clouds, no opportunity has occurred of obtaining a further record.

Liverpool, October 7th. R. C. Johnson.

THE VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—It is possible to present important evidence as to the visibility of Venus as a crescent many thousands of years before the invention of the telescope, from an archæological point of view, and that of such convincing character as to determine the question as to the early members of the human race, at any rate.

The planet Venus was the symbol, and associated star of, the great Babylonian, Phœnician, and Syrian goddess, Ishtar = Ashtoreth = Astarte; and one of the commonest attributes of this deity was a horned head-dress, and indeed she was known, as we find in the Old Testament and Phœnician and Carthaginian inscriptions, as "Astoreth-Karnaim," *i.e.*, "of the (2) horns," and had one or more temples of that name, probably placed upon a double-peaked mountain resembling the curve of a pair of horns.

Because of these attributes, and led astray by the statements of two late classical authors, Lucian and Herodian, many writers have termed her a lunar deity, but this is incorrect. She was undoubtedly considered by the Greeks as the counterpart of, or identical with Venus = Aphrodite. At the shrine of Aphrodite, at Afca, she was worshipped as a star. But we have much more decisive proof of Ashtoreth = Astarte being Venus, in that she was nothing else than the Aramaic, Phœnician, and Syrian form of Ishtar, the celebrated goddess of Babylon and Assyria.*

Ishtar undoubtedly was Venus, certainly not the moon, because at Babylon the Moon God was masculine; and the connection between the cult of Ishtar = Aphrodite = Venus as a voluptuous deity is well known.

There is in fact no straining of any of the evidence in stating that everything proves the horned Astarte = Ishtar = Astoreth-Karnaim to be the goddess personified by the planet Venus.†

What has to be accounted for is the universal acceptance of a crescent, or horns, for her most well-comprehended symbol. This, I think, can only have arisen from the crescent shape of Venus having been observed, and so properly associated with the deity. So much, indeed, did her symbol coincide with that of lunar deities, that when the true origin of the connection was forgotten, it caused the slight confusion we have mentioned in two of the later extant classics between Astarte and the Moon Goddess. In the clear air of Mesopotamia, no doubt it was possible to detect the phases of Venus, and so Ishtar = Venus = Astoreth-Karnaim is like many another early human concept, a reasonable expression of primitive symbolism.‡

Joseph Offord.

[I do not feel myself able to agree with Mr. Offord that the evidence which he presents as to the Babylonians having been aware of the phases of Venus is sufficiently convincing. It seems to me at least a plausible suggestion that the Babylonians saw some analogy between Venus and the Moon, and ascribed symbolically some of the Moon's attributes to her. It is not impossible even that they may have argued out the Copernican idea of the solar system, and consequently have deduced that Venus ought to show phases.

But if the Babylonians really observed the phases of Venus, and it can be shown that they did, I think we cannot escape the conclusion that they must have had telescopes. I believe the recognition of her crescent with the naked eye is entirely impossible.—E. Walter Maunder.]

* The two divergent ideas associated with Astarte-Aphrodite, of gentleness and feminity with fierceness and heat, probably are connected with Venus as the morning star, goddess of the dew and of moisture and fertility, and as evening star, when the heat accumulated during the day and proceeding from the level rays of the setting sun is still so oppressive.

† A Babylonian cylinder, edited by Père Scheil, shows Ishtar as a cow, and recently some votive offerings of cows heads of an African type have been discovered in the Balearic Isles, no doubt from a Phœnician Ashtoreth shrine.

‡ In ancient Arabia Venus was a male god, no doubt connected with the Assyrian Sin, but strange to say the Arabs, or "Mineans," called him Athtar, apparently to secure the favours of both principals of the deity as worshipped by their kinsmen, by giving him the sex of the one form and the title of the other.

EXTINCTION OF QUAGGA.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I sent a skin of *Equus quagga* to Stevens' sale rooms, Covent Garden, for sale, about the time mentioned in the October number of KNOWLEDGE.

I thought it possible it was the skin bought by the Edinburgh Museum. If it is the same, I can correct the inference made by Mr. Renshaw that the quagga survived in the Orange Free State till about that date.

The specimen, as he suggests, was an old one. I brought it to England with other skins, horns, birds, and insects, in 1860, and kept it till the date of sale.

I once caught a young quagga alive. My waggon was outspanned near to a Dutchman's waggon; the Dutchman had been hunting quaggas, etc., and had scattered the herd of quaggas, and this young one was lost. We supposed it had followed the horses. It was here and there and everywhere round about the waggons and oxen. It was dark; we followed it by its cry, "Quag ha," and I caught it.

Marathon, THOS. COOPER.
6, The Avenue, Kew, Surrey,
October 3rd, 1902.

A MODERN TYCHO.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I should like to make a few remarks with reference to Mr. Maunder's comments on my letter *re* Jey Singh in your August number.

Mr. Maunder, I now understand, considers that Jey Singh's observations and methods are scarcely practical, and that the results he achieved could have been obtained with much less elaborate and costly instruments, and in a more simple manner. I cannot help thinking that he would modify this opinion if he had seen the Jeypore Observatory and had studied Jey Singh's works.

On his commencing astronomy, Jey Singh first made use of brass instruments fitted with sights, but he could not obtain accurate workmanship, and, after a short trial, he almost entirely gave up brass, and constructed large masonry instruments, in which there were no axes to wear out of truth, and in which, owing to their size, minute accuracy of workmanship and graduation were not required. Mr. Maunder states that he observed no special arrangements for fixing the position of the eye, but in one of Jey Singh's works, what is termed "an observation strip and tube" is described, and appears to be an arrangement for this very purpose.

Jey Singh determined latitude with the *bhitti yantra*, a large graduated stone circle, in the plane of the meridian, with which meridian altitudes were observed. This gave the angle for the inclined face of the gnomon. By placing the eye along the graduated edge of one of the quadrants, and watching the disappearance of the sun or a star behind the edge of the gnomon, hour angles or time could be obtained with great precision, surely with far greater accuracy than with a comparatively small sun-dial.

The circular buildings Mr. Maunder alludes to are at Jeypore, adapted for taking observations at all altitudes.

No doubt Jey Singh might have done excellent work with much simpler means, but he had the money to spend, and so preferred to build the best instruments he could. But before denouncing his methods as impractical, it should be remembered that minutely divided brass circles and turned axes were denied to him, and that he was consequently driven to strive after accuracy by increasing the size and stability of his instruments.

If I have the opportunity, I will make some observations as suggested by Mr. Maunder, but unfortunately most of the instruments have either been restored or completely reconstructed since Jey Singh's days.

A report on the Jeypore Observatory is in the press, and if Mr. Maunder would care to accept a copy, I shall be very pleased to send him one.

India, August, 1902. A. ff. GARRETT, Lt. R.E.

[I think Mr. Garrett has not quite grasped my point even yet. The erection of a huge stone instrument, gnomon, meridian circle, etc., means the *previous* determination of the meridian—in some cases of the latitude as well—with a precision greater rather than less than that shown by the building itself. In other words, the erection is in itself a demonstration that results more, not less, accurate were first of all secured by temporary instruments. A modern equatorial is set up approximately in the meridian and to the latitude of its station; but its accurate placing is secured later by the use of the optical power of the telescope itself in testing the effect of minute movements given to it by fine adjusting screws. There is no provision in the gnomon or circles at Delhi for a slow motion in azimuth, any more than there was for the Great Pyramid at Ghizeh. Then I cannot accept Jey Singh's complaint quite seriously as to the imperfection of his brass instruments, "the shaking and wearing of their axes, the displacement of the centre of the circles, and the shifting of the planes of the instruments." It seems to me that the wearing of the axis of a brass instrument could hardly have made itself apparent to the naked-eye observation in "a short time." Surely he could have got native metal-workers to do better than this if he had cared to try. We have plenty of evidence of their skill in the making of armour, etc. But I can quite understand that he may have had abundantly sufficient political and religious reasons for preferring the plan of solid buildings. The latter were, no doubt, an effective advertisement, and testified to his wealth, science, and religious zeal; whereas a few light instruments, seen only by the observers, would not have done so. Such reasons would be amply good enough to justify the course he adopted, but they would not be astronomical.

I am greatly obliged by Mr. Garrett's promise to make some practical observations with the Jeypore Observatory, and I shall most heartily appreciate the report on that observatory which he has kindly offered to send me. —E. WALTER MAUNDER.]

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

THE BRITISH WHITE-FRONTED GEESE *(Anser albifrons, A. erythropus,* and *A. gambeli).*—Several ornithologists have been turning their attention lately to the geese which are to be found in Great Britain and Ireland. It is refreshing to find from their labours that there is still some systematic work to be done among British birds.

In the *Ibis* for April, 1902 (pp. 269-275), Mr. J. H. Gurney has a useful article on the three White-fronted Geese, *Anser albifrons*, *A. erythropus*, and *A. gambeli*; while in the *Zoologist* for September, 1902 (pp. 337-351), Mr. F. Coburn treats of the same three birds, with special remarks upon *A. gambeli*. Without entering minutely into the question, which would be out of place here, Messrs. Gurney and Coburn give fair evidence for their conclusion that these three geese are specifically distinct, and that they all occur in the British Islands. Briefly stated, *Anser albifrons* and *Anser erythropus* inhabit the greater part of Europe and Asia, but *A. albifrons* does not go so far north as its near ally. *A. albifrons* is the White-fronted Goose usually found in Great Britain, while *A. erythropus* was first noticed as a British bird in 1886, and has been procured but seldom since then in this country. *Anser erythropus* is a much smaller bird than *A. albifrons*, not only in its body but also in its beak, while its plumage is slightly darker, and the white of the face and forehead is more extended than that in *A. albifrons*. *Anser gambeli* is a North American species, and may be regarded as the New World representative of the White-fronted Geese. It is closely allied to *A. albifrons*, but may be distinguished from that species by its larger and heavier bill and darker under parts. Besides these differences Mr. Coburn has found that *A. gambeli* has a considerably longer neck than *A. albifrons*, a distinction which is made more valuable by his measurements having been made from birds in the flesh and not from skins. Mr. Coburn was the first to recognise that *Anser gambeli* is to be found in the British Islands. The first specimen which drew his attention to the subject was procured in Co. Mayo, and he has since found several others, but all, it appears, from Ireland. However, now that the differences between these three birds have been pointed out, specimens of the supposed *A. gambeli* may be found in many collections, and the question thus thoroughly examined. Mr. Coburn gives some valuable descriptions of the various changes of plumage in the two larger White-fronted Geese, but his dogmatic assertions as to how these changes are effected are supported by insufficient evidence.

THE BRITISH BEAN-GEESE.—Hitherto but two species of Bean-Geese have been recognized in the British Islands, viz., the Pink-footed Goose (*Anser brachyrhyncus*) and the Bean-Goose (*Anser segetum*). In the *Field* for October 4th, 1902 (p. 605), Mr. F. W. Frohawk describes how that in figuring the various European geese for M. Serge Alphéraky's work on the Geese of Russia, he has found that the true *A. segetum* is really very rarely found in this country, and that the bird which is usually so identified is in reality *Anser arvensis*. Mr. Frohawk does not give the range of the two species, but it appears that *A. arvensis* is by far the commoner bird in Europe and Asia. The two species differ apparently only in the bills. In *arvensis* the bill is slightly longer and straighter than that of *segetum*, while the "nail" of the bill is smaller in proportion and more rounded. In colour the bills of the two birds appear to differ markedly, that of *segetum* being black, with a band of orange between the "nail" and the nostrils, while that of *arvensis* is almost wholly orange-coloured on its upper portion, while the lower is about one-third orange and two-thirds black.

GLOSSY IBIS IN THE SCILLY ISLANDS AND IN HEREFORDSHIRE.—We have received two Glossy Ibis for preservation; one yesterday from the Scilly Isles, and another to-day from Herefordshire. We hear that there were two in the Scilly Isles, but only one obtained.—PRATT & SONS, Brighton, October 15th.

Cirl Bunting in Ireland. (*Zoologist*, September, 1902, p. 353.)—Mr. H. E. Howard here records that near Dunfanaghy, Co. Donegal, on August 2nd, he watched a Cirl Bunting (*Emberiza cirlus*) within a few yards. The Cirl Bunting has not been recorded hitherto in Ireland.

Observations on the Weights of Birds' Eggs. By N. H. Foster. (*Irish Naturalist*, October 1902, pp. 237-245.)—The weights and measurements of a number of eggs of 56 species of birds found in Co. Down, Ireland, are given here.

Increase in the Numbers of Breeding Birds in Mayo and Sligo. By Robert Warren. (*Irish Naturalist*, October, 1902, pp. 246-249.)—Mr. Warren here gives some interesting notes on the increase during the last few years of Starlings, Rooks, Blackbirds, Shovellers, Shelldrakes, Common Gulls, and Arctic and Lesser Terns in the counties mentioned

Report on the Movements and Occurrence of Birds in Scotland during 1901. By T. G. Laidlaw. (*Annals of Scot. Nat. Hist*, pp. 66-82, 129-136, 193-199).—Mr. Laidlaw's annual report of the movements of birds in Scotland is always a careful and useful contribution.

Gulls killed while following the Plough. (*The Annals of Scottish Nat. Hist.*, October, 1902, p. 251.)—Mr. L. H. Irby records how that in the Island of Coll this spring four Common Gulls were killed or disabled while closely following a plough by the tilth turned up by the plough falling back on them.

Starling Roost on Cramond Island. (*The Annals of Scotl. Nat. Hist.*, Oct, 1902, p. 252.)—The Starling roost referred to in KNOWLEDGE for February last, page 35, is reported by Mr. Chas. Campbell to be now deserted. A good number of trees have been killed by the droppings of the birds, and the stench of the place is very disagreeable. Mr. Campbell thinks that the average length of time these birds occupy a particular roosting place in great numbers is five years.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at the Office of* KNOWLEDGE, 326, *High Holborn, London.*

NOTES

ASTRONOMICAL.—There can be little doubt that the spectroscope will eventually give precise values of the rotation periods of the planets which have no surface markings sufficiently distinct for the application of the ordinary telescopic method, as it has already done for those parts of the sun which lie outside the spot zones, and for the rings of Saturn. M. Deslandres, of the Meudon Observatory, has given much attention to this work, and among his latest results is the determination that the rotation of the planet Uranus, like the revolution of the satellites, is in a retrograde direction. The method employed is to place the slit of the spectroscope along the equator of the planet, so that the rotation produces an inclination of the lines as compared with those given by a source of light which is at rest.

During the total eclipse of the sun, May 18, 1901, Mr. Perrine, of the Lick Observatory, took advantage of the opportunity of making a photographic search for an intra-Mercurial planet. After a minute examination of the negatives, he now reports that there is no planetary body as bright as 5·0 visual magnitude within 18° of the sun, whose orbit is not inclined more than $7\frac{1}{2}°$ to the plane of the sun's equator. Within two-thirds of this region it further appears that there was no such body as bright as $7\frac{3}{4}$ magnitude, unless at the time of eclipse such a body was in direct line with the sun or with the brightest part of the corona. Were there any considerable number of such bodies as bright as $7\frac{3}{4}$ magnitude it is probable that some would have been detected. A planetary body of this magnitude would be thirty-four miles in diameter. As seven hundred thousand bodies of this size, and as dense as Mercury, would be required to produce the outstanding changes in the orbit of Mercury, it no longer seems possible to attribute these perturbations to bodies of considerable size between Mercury and the sun. It is not considered impossible, however, that the finely-divided matter composing the Zodiacal Light is sufficient in the aggregate to cause the recorded disturbances of Mercury's orbit.—A. F.

Botanical.—The method of dispersal of the seeds of *Viola canina* are, perhaps, generally known through the observations of Kerner. When the capsule dehisces, the hard smooth seeds, which are attached to each of the three valves, are subjected to so much pressure by the contraction of the sides of the valves, that they are squeezed out and sometimes thrown to a distance of three feet. Mr. R. G. Leavitt has noticed the seed dispersal of another species, *V. rotundifolia.* In some instances, he states in *Rhodora* for September, the seeds are merely pushed out; many of them fall within a foot of the capsule that contained them; but others are thrown a distance of five feet, and he shows that in one case the distance reached, apparently by these means alone, was nine feet.

Monsieur C. De Candolle has published two papers on a curious Indian *Ficus*, remarkable in having all its leaves transformed into small pitchers. The second paper appears in the last number of the *Bulletin de l'Herbier Boissier.* Prof. Buchenau has recorded an instance of a pitcher-shaped leaf in the common fig (*Ficus Carica*), but this was merely accidental, and, as is usually the case, the inside of the pitcher was formed by the upper side of the leaf. In the plant investigated by Monsieur De Candolle the leaves appear to be normally pitcher-shaped, and the pitchers are extraordinary in having their interior formed by the under side of the leaf.

The botanical collections made during the visit of the Danish Expedition to Siam, in 1899–1900, have been investigated by various botanists, and the results are being published in the *Botanisk Tidsskrift*, in a series of papers edited by Dr. J. Schmidt. All the plants were obtained from Koh Chang and other smaller islands in the Gulf of Siam. The last part published (part 7) contains several new species of Dipterocarpaceæ, which have been described by Prof. Heim. Of the fourteen species enumerated no less than seven are new. This order appears to be exceptional with regard to the number of novelties, for on the whole the collections contain very few previously unknown plants. All the nineteen Compositæ brought from the islands are found in the eastern part of British India.—S. A. S.

Zoological.—In an article on four-horned sheep published in Knowledge for July, 1901, it was suggested that the duplication of the horns in those breeds was due to splitting of the normal pair. This suggestion has been made a practical certainty by a skull of a South African piebald ram recently presented to the British Museum by Mr. W. P. Pycraft. In this specimen each horn is cleft to within a short distance of its base; the minor branch, which is inferior in position, lying close alongside the larger. It may be added that the sheep of this breed, which appear to have come originally from Zululand, but have been introduced into many parts of Europe (inclusive of Great Britain), frequently develop two pairs of horns. These differ from those of the ordinary four-horned sheep of the Hebrides not only by their colour, which is black, but also in form.

From a bed of gravel near Greenhithe, Kent, known, on account of the number of shells of that genus it contains, as the Neritina-bed, Mr. E. P. Newton, in the September number of the *Geological Magazine*, describes a large rodent incisor which he believes to be referable to the giant beaver (*Trogontherium cuvieri*). Hitherto remains of that species have been known only from the Norfolk forest-bed. If the present specimen be correctly identified, it tends to show that the latter deposit is of Pleistocene, and not, as supposed by some, of Pliocene age.

In the *Annals and Magazine of Natural History* for September, Mr. O. Thomas describes from Szechuen a larger form of that beautifully coloured animal the panda, or cat-bear, of the Himalaya, under the appropriate name of *Ælurus fulgens styani*, bestowed in honour of Mr. Styan, who has done so much to increase our knowledge of the fauna of North-Western China.

An even more interesting animal is described in the October issue of the same journal by Mr. Thomas. This is the eastern form of that large and handsome antelope commonly known as the bongo (*Tragelaphus euryceros*), the first skin of which to be received in this country was obtained by M. du Chaillu on the West Coast. Of the eastern representative of this antelope a fine series of skins and horns from the forest district to the eastward of the Victoria Nyanza have recently been presented to the Natural History Museum by Mr. F. W. Isaac. These specimens show that, in the eastern race at any rate, the bongo differs from its cousins the bushbucks in that the females as well as the males carry horns. This necessitates the reference of the former animal to a distinct genus, which it is proposed to call *Böocercus*, in allusion to the tufted, ox-like tail. Since the eastern race differs somewhat in the horns and skull from the typical western form, Mr. Thomas designates it *B. euryceros isaaci.* It is a remarkable circumstance that the elands and bongos, the two representatives of the tragelaphine antelopes with horns in both sexes, also differ from their relatives in having tufted, in place of fully haired, tails.

In the same number Mr. R. I. Pocock publishes a revised classification of the existing members of the horse family. After assenting to the view that the Asiatic members of the family, namely, Przewalski's horse, the domesticated horse, and the kiang, or chiggetai, form a group by themselves, the author points out that the North African wild ass and the mountain zebra of South and South-West Africa are very closely related to one another. Burchell's zebra and its subspecies, on the other hand, come so close to the true quagga (whose name they have usurped) that Mr. Pocock regards the whole series as local variations of a single species, for which the name *Equus quagga* stands. Very distinct from all the rest, in the author's opinion, is Grévy's zebra, of Abyssinia and South Somaliland. From this it will be gathered that Mr. Pocock attaches little or no importance to the presence or absence of striping in this group as indicative of affinity.

The discovery of a new vertebrate fauna of Middle Cretaceous age in the north-west territories of Canada is a circumstance of more than ordinary interest, especially since among the remains are teeth of two species of mammals. The new fauna, so far as it is at present known, is described by Messrs. Osborne and Lambe in *Contributions to Canadian Palæontology* (Vol. III., pt. 2); Professor Osborne dealing with its general characters and relations, and Mr. Lambe discussing the genera and species. The reptiles include several chelonians and dinosaurs; among the latter being a species of *Trachodon* (a relative of the iguanodon, but with pavement-like teeth), of which the impression of a portion of the skin is preserved in the matrix. The best of the two mammalian specimens belongs to a form nearly allied to the little *Plagiaulax* of the Dorsetshire Purbeck, a species ever memorable on account of the controversy which took place as to whether it was herbivorous or carnivorous.

Notices of Books.

"Animal Forms: A Second Book of Zoology." By D. S. Jordan and H. Heath. (London: Hirschfeld.) Pp. vii. + 258. Illustrated.—If American writers intend to make a serious attempt to capture the English market for zoological text-books, they would do well to see that their work is suited to its environment. In a volume bearing only the name of an English publisher, and betraying to those unacquainted with the nationality of its authors no indication of its trans-Atlantic origin, save certain peculiarities of orthography and diction, it is nothing short of absurd to find that the expression "this country" means North America. For example, the student is likely to be puzzled by the statement on page 241 that "in this country the group [of cats] is represented by the lynx (*Lynx canadensis*), the wildcat (*L. rufus*), and the panther or puma (*Felis concolor*)." Neither is the sentence (p. 239) that "the native hollow-horned ruminants (*Bovidæ*) are at present confined to the western plains, and comprise the prong-horned antelope, the wary bighorn or Rocky Mountain sheep, and the bison or buffalo," calculated to make matters clear to the mind of the average English reader. We might, moreover, take exception to the last sentence on the ground that the pronghorn is not generally regarded as a member of the *Bovidæ*. A further objection we venture to make is the employment of American misnomers in a work professedly English, as exemplified by the title "American elk" to the plate of Rocky Mountain wapiti. If it is worth while to publish an American work in a professedly English guise, the least the authors can do is to prepare an edition specially revised for the new field. As regards the character of the work itself, we are glad to be able to express a favourable opinion, the descriptions of the various groups being couched in language easy to be understood by the beginner, and the illustrations admirable in character and in execution. Especially striking and original is the figure of a group of lamp-shells on page 69, where the artist, by the ingenious introduction of a cliff of carboniferous strata, has been enabled to show the members of an extinct family alongside their living representatives. The classification adopted is in the main well up to date, and the use of technical terms avoided as much as possible. We are, however, somewhat surprised to see the lancelet included among the fishes, instead of with the protochordates; and we are still more astonished at the statement (p. 231) that "the duck-moles are the only mammals which lay eggs." So far as we are aware, it is only the spiny anteaters that are definitely known by ocular evidence to lay eggs; and it is commonly asserted that the duck-mole produces a pair of young annually (presumably in the form of eggs), and not a single one, as stated by the authors. If revised on the lines pointed out above, the volume before us may lay claim to a share of patronage by English students.

"Webster's International Dictionary." A new edition with Supplement. (George Bell and Sons.)—If we refrain from declaring this magnificent work to be the best dictionary, it is only because we do not work habitually with Webster; but we entirely agree with the late Lord Pauncefote in his appreciation of the extraordinary learning and industry which have been bestowed upon the work. Its American origin is, of course, a disadvantage to it among English students and litterateurs, but it is a work of the utmost practical utility, and is certainly among the best working dictionaries of the English language.

"The Elementary Principles of Chemistry." By Prof. A. V. E. Young. Pp. xiv. + 252 + 106. (Hirschfeld Bros., Limited.) Illustrated. 5s. net. "Elements of Physics." By Dr. C. H. Henderson and Prof. J. F. Woodhull. Pp. x. + 388 + 112. (Hirschfeld Bros., Limited.) Illustrated. 5s. net.—These two volumes belong to a series of Twentieth Century Text Books, designed to meet the demand for short treatises written from the point of view of modern science in literary style, accurate diction, and laboratory mood. The aims are high, but they are true; and though it would be too much to say that the authors have been completely successful, yet their books are well worth the attention of teachers and students. Each book consists of a theoretical or descriptive part, and a second part, with separate pagination and index, containing details for illustrative experiments in laboratory and lecture room. Full-page portraits are given of distinguished men who have contributed to the progress of science, and the illustrations of apparatus are in most cases admirably done.

Prof. Young has produced an inspiring and philosophical work, which should be of real assistance to students of chemistry. Beginning with general considerations as to properties of bodies of practical importance, he passes to fundamental laws of chemical action, equivalent and combining weights, the atomic theory, and then the chief elements and their compounds, taken collectively and separately. The experimental work referring to points in the text is of an instructive character, and the hints on the manipulation of apparatus and materials will be found useful. The separation of the experiments from the descriptive text has the advantage of permitting an unbroken argument to be stated, but there are some objections to it when the text is made to depend upon the students' experiments. A better plan is to make the text a didactic statement of experience, to be read by the student before or after he has done his practical work, but not actually depending upon his results. In the example of a record from a laboratory note-book, given on page 103, two long division sums and one multiplication are worked out. Students who use a book of the type of Prof. Young's ought not, however, to do sums in this way, but by the use of logarithms. But these are minor points, and do not prevent the book from containing as good a survey of chemical science and philosophy as it is possible to give within its limits.

The text-book of physics by Drs. Henderson and Woodhull is more of the conventional type than Prof. Young's volume; in fact, we have found little to distinguish it from other manuals of physics, either in scope or treatment. Three kinds of levers are classified, though the division is quite unnecessary; the wave theory of light does not receive sufficient attention; no experimental method by which the velocity of light has been determined is described, and most of the matter is of a very elementary character, though this is partly accounted for by the extent of the subject. The standard of the work is about that of first and second year students in schools of science, or the junior division of the Oxford and Cambridge Universities' Local Examinations. For such students the descriptive text and experimental course would be found very suitable.

"European Fungus Flora: Agaricaceæ." By George Massee. (Duckworth.) 6s. net.—In a single volume of handy size, Mr. Massee lists and describes the Agarics of Europe. To accomplish this task in 280 pages requires a large amount of condensation, and hence we find the description of each species occupying on the average but three lines, essential characters only being mentioned. No attempt is made to indicate the range of the species, except that non-British plants are enclosed in brackets. As a key to this great group of fungi Mr. Massee's work will be of much value, while the author's name will carry with it confidence in the critical worth of the work. It is somewhat discouraging to the beginner at British Agarics to learn that the foreign species mostly fit in between the British ones, when the difficulty of discriminating between many of our native species is remembered. Altogether 2750 species are described, of which 1553 are known to occur in Britain—a considerably greater number, Mr. Massee remarks, than is at present on record from any other European country. A useful Bibliography of more recent and important works is appended; under Great Britain it is strange to find no mention of Stevenson's *Hymenomycetes*, the most important British book on the subject. There is a full index of species, and the book is excellently printed and neatly bound.

We have received from Messrs. Erdmann & Schanz one of their "Triumph" Aluminium Stereoscopes, together with a selection of stereo slides, representative of some of the several series catalogued by this well-known house.

BOOKS RECEIVED.

Kathlamet Texts. By Franz Boas. (Smithsonian Institution.)

Niels Henrik Abel Memorial Publie a L'occasion du Centenaire de sa Naissance. (Williams & Norgate.) 21s. net.

The Cat Manual. By Dick Whittington. (Newnes.) 1s. 6d. net.

Science Teacher's Pocket Book and Diary, 1902-3. (Woolley.) 1s.

How to Buy a Camera. By H. C. Shelley. (Newnes.) Illustrated. 1s. 6d. net.

Art of Extempore Speaking. By Harold Ford, M.A., LL.D., D.C.L. Third Edition. (Elliot Stock.) 2s. 6d. net.

Junior Chemistry. By E. A. Tyler, B.A. (Methuen.) Illustrated. 2s. 6d.

Birds in the Garden. By Granville Sharp, M.A. (Dent.) Illustrated. 7s. 6d. net.

Explanations of Terms and Phrases in English History. By W. T. S Hewett, B.A.LOND., D.C.L. (Elliot Stock.) 1s. 6d. net.

Manners and Customs of the Modern Egyptians. By Edward William Lane. (Ward, Lock.) Illustrated. 2s.

Hydrographical Tables. Edited by Martin Knudsen. (Williams & Norgate.) 5s. net.

Flora of the East Riding of Yorkshire. By Jas. Fraser Robinson. To which is added a *List of the Mosses of the Riding.* By J. J. Marshall. (A. Brown & Sons, Ltd.) 7s. 6d.

List of Observations. (Smithsonian Institution.)

Journal of the Society of Comparative Legislation. (Murray.) 5s.

Royal Astronomical Society's Reprints, Nos. 45, 48, 54 to 63, and 65.

Meteorological Observations at the Royal Institution of Cornwall, 1850-1900. Compiled by George Penrose.

Commercial Supremacy and Military Service. By Sir James Blyth, Bart.

Penny Chronology. Third Edition. By William Thynne Lynn, B.A., F.R.A.S. (Sampson Low.)

Literature and Dogma. By Matthew Arnold. (Watts & Co.) 6d.

INSECT ODDITIES.—II.

By E. A. BUTLER, B.A., B.SC.

IN our last paper, some of the oddities of insect life were selected from that single order which is so prolific in queer creatures, viz., the Hemiptera. In the present one, our selection will be made from the rest of the insect world, so far as it is represented in the British Isles. But before entering upon the description of these additional oddities, it may be worth while to point out that another very excellent example would have been taken from the order Hemiptera, had it not been already dealt with in a previous number of KNOWLEDGE. If the reader will turn to Vol. XVII., p. 148, he will there find a short account of the insect called *Orthezia urticæ*, a fairly common species belonging to the so-called scale-insects, and one which, at least in the female sex, looks more like a piece of sculpture in alabaster, or a cast in plaster of Paris, than a living insect, and it is well worthy of a place in our gallery of oddities.

Turning now to the order Hymenoptera, that of the bees, wasps and ants, we will select a curious creature belonging to a small section of the order called *Proctotrupidæ*. This section contains the smallest of all Hymenopterous insects, many of which are so minute that they are able to spend their whole larval life within the *eggs* of other insects, finding in the contents of a single egg sufficient food to last them their lifetime. The insect we select, however, is much larger than this, though it also is a parasite. It is called *Gonatopus pedestris* (Fig. 1), and its place here, at the head of the present paper, is a most appropriate one, as it is parasitic upon insects of that group which yielded most of the illustrations in the former paper.

FIG. 1.—*Gonatopus pedestris.*

If we find in August or September a field in which the herbage has been allowed to grow long and dry, and sweep with a net amongst the long grass-stalks, we shall probably capture hundreds of small brownish or yellowish frog-hoppers, belonging chiefly to the two genera *Athysanus* and *Deltocephalus*, the former being the larger of the two. Amongst this crowd of jumping creatures, we shall probably notice a few individuals which seem more or less deformed. They are incommoded by having a large black wen-like excrescence growing from some part of the body, generally the fore-parts, and especially at the side of the head, at the junction between it and the thorax (Fig. 2). By this we know that the insect is suffering from the attack of a parasite which is either our *Gonatopus*, or something akin to it. The black excrescence is, in fact, a sort of case which contains inside it the grub of the parasite. The juices of the host are diverted from their true course to pass through the slender attachment of this black bag to the body, and so to nourish the larva contained within it.

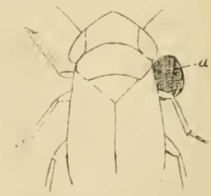


FIG. 2. — Fore-parts of *Athysanus obsoletus*, with parasite (*a*).

The case is something like an oval box constructed in two parts, which unite together all round the edge. The larva within is a footless maggot, which has a very easy time of it, being fed entirely at the expense of its host, while it has nothing to do but lie still and enjoy itself. When it is full grown the black skin bursts, the lid coming off as it were, and the imprisoned insect escapes, and soon spins a little cocoon somewhere in the neighbourhood. From this cocoon emerges in due time a most odd-looking creature (Fig. 1), something like an ant in general appearance, but with a disproportionately large head, and a most extraordinary pair of fore-legs. A large part of the head is occupied by the huge masses of the compound eyes. The thorax is greatly elongated, chiefly in consequence of the large size of its first segment, the prothorax, which is much more fully developed than is usually the case in this order of insects. There is nothing remarkable about the body, nor about the two hind pair of legs, save that they are rather long and thin, and that their thighs are clubbed. But it is the fore-legs that constitute the most important part of the creature's anatomy, for upon their skilful manipulation depends the solution of the question whether the insect shall be able to secure for itself a posterity, or whether its line is to become extinct with itself. Of course, it is the female insect we are referring to throughout.

To provide for the deposition of its eggs, it will have to catch a suitable froghopper, and every entomologist knows that this is one of the most difficult tasks to which he can be set, for of all insects the froghoppers are the most agile and the most wary; their awkward habit of suddenly kicking out with their hind legs, and so jerking themselves violently through the air from place to place, makes them the most tantalizing of objects to hunt. To meet the difficulties of the situation, therefore, we find that *Gonatopus* is doubly well equipped. In the first place, there are those huge masses of eyes on each side of the head, by which a wide horizon can be scanned, and a good look-out kept for the discovery of a suitable quarry. And then there are the fore-legs, which are a *multum in parvo*, and remind one of those household implements which are many tools in one—hammer, screw-driver, pincers, and the like. The leg is not merely a walking machine. It has an extra thick thigh, which means good muscles for the rapid and forceful movement of the whole limb.

Then comes the long and thin shank, which is succeeded by a foot, the like of which we may search for elsewhere in vain. Instead of the pair of claws by which an insect's foot is usually terminated, there is an apparatus proportionately very large and most awkward looking, and reminding one of a boy's clasp knife (Fig. 3). Being in reality a modified pair of claws, it consists of two parts, one of which is broader, turned up at the tip, and furnished with stiff bristles along its inner edge, and this corresponds to the hasp of the knife; the other is thin, blade-like and pointed, and represents the blade. The claw-like blade can be opened out fully so as to be in a line with the stouter hasp, or it can be completely closed upon the latter just as the blade upon the hasp. The whole apparatus is attached to the rest of the foot at the hinge where its two parts move upon one another, and, therefore, though symmetrically disposed with regard to the foot when open, it hangs down on one side when closed, and gives a most unsymmetrical and malformed appearance to the limb. This curious apparatus acts as a pair of pincers, and its function is evidently to seize hold of the bristle-like hairs of some froghopper less wary than usual, so that it may be detained to serve as a host for the egg of the parasite. It can hardly seize anything much larger than the hairs of its quarry, as the whole apparatus is so minute that a microscope is necessary in order to make out its details.

For our next oddities we will go to the order Diptera, or two-winged flies. There is a certain section of this order the members of which are external parasites on warm-blooded vertebrates, and as habits of this kind often produce great modification in the form of the parasite, we need not be surprised that some of the insects referred to are so changed as to be scarcely recognisable as flies. They are generally flat-bodied, shiny creatures, with bristles scattered over the body, and with stout legs ending in strongly curved and very powerful claws. The single pair of wings which distinguish dipterous insects are usually present, though often greatly modified in form; but sometimes they are altogether absent, and the insect is quite apterous, so that none but an expert would suspect its near relationship to the active and vivacious flies.

Fig. 3. — Claws of *Gonatopus pedestris*. Highly magnified.

Our first example may be the "bird-fly," *Ornithomyia avicularia*, which is a parasite on birds, and sucks their blood in much the same way as the bed-bug does that of humankind. This insect shows very well the flattened head and thorax which are so common in the group; its wings are ample and it can fly well. The claws are large in proportion to the size of the body, and they are very powerful and permanently bent abruptly inwards, reminding one of the corresponding structure amongst vertebrates in the hand or foot of a sloth. The claw of an allied insect is shown at Fig. 5a. This arrangement, while it unfits the insects for walking easily on flat surfaces, gives them a wonderful tenacity of grip on uneven surfaces, and makes it difficult to dislodge them from the feathers of the birds on which they live. They are very vivacious insects, running with great agility, often sideways like a crab, and easily eluding pursuit by burying themselves in the feathers of their host. These parasitic flies, though exhibiting the habits of lice, must not be confounded with the true bird-lice, which are very different and much smaller insects, apterous and constituting a distinct order called Mallophaga.

A rather larger insect, somewhat similar to the bird-fly, but with dark shiny brown body, attacks horses in the same way, and is sometimes exceedingly troublesome to them. In accordance with its habits, it is called *Hippobosca equina*. It has a very tough body which can stand a great amount of pressure without being harmed—a very useful attribute when one thinks of the risks it must often run in getting into narrow corners, under harness, &c. The head of this insect is worth a careful examination under the microscope, as it shows the sort of structure an insect often takes on in becoming parasitic. Everything is arranged with a view to the least resistance in passing amongst the hairs of the animals on whose blood it feeds. The surface of the skin is very polished and well rounded, without prominences which might get in the way. The outline of the head is continued in the eyes, and the antennæ are neatly disposed of by being sunk in a couple of pits. They usually stand out prominently on a fly's head, and if that were so in the present case, they would no doubt be an impediment to rapid progress amongst a forest of hairs. But they are much shortened and consist mainly of a large round knob, surmounted by a long and strong black bristle, which is the only part visible outside, all the rest being sunk in the pit. It is curious that an exactly similar contrivance may be found in another parasite, though a very dissimilar one, viz., the common flea. Between the antennæ, and at a little lower level, is a sort of black beak which ensheaths the piercing apparatus. This latter contains bristles strong enough to penetrate even the tough hide of a horse, and thereby cause intense irritation.

The swallow louse, *Stenopteryx hirundinis* (Fig. 4), is another of these parasitic flies. It has the same flattened and polished body, and the same stout legs and curved claws, the former green and the latter black, as usual. But it has advanced a stage on the road to the apterous condition; the wings are reduced very much in breadth, and look as if all the inner parts had been cut away with a pair of scissors, only the outer and stronger edge being left. The creature lives parasitically upon swallows, making its way, crab fashion, amongst the feathers till it reaches the skin, which it pierces with its beak for the sake of the blood. If the host dies, the fly is not long in discovering the fact, and it forsakes the now useless body, flying away till it encounters some other living being on which to alight and try the strength of its beak. If this does not happen to be a bird, the fly soon leaves it and proceeds on its travels till a more suitable host is discovered. When thus free, it is sometimes troublesome to human beings. The Rev. W. Kirby mentions a case in which one of these creatures behaved just like a bed-bug, establishing itself in a bed and greatly worrying the occupant for several nights without his suspecting the true nature of the annoyance, till at last a close and careful search brought the culprit to light. Curiously enough, when I had reached this point in writing this paper, a living specimen of this same fly was brought me, which had settled upon a person walking by the side of a wood, and had startled him by its quaint form and strange motions, so that he captured it at once.

Fig. 4. – Swallow louse (*Stenopteryx hirundinis*).

This swallow louse, as mentioned above, has got its wings abbreviated, and it seems likely that in the course of time its descendants may have theirs still further reduced, and may ultimately lose them altogether. Such a stage has, in fact, already been reached by one member of the group, which has thus lost all resemblance to a fly, and, in fact, is popularly regarded as hardly even an insect, being called the sheep-tick (Fig. 5). This name, however, is a misnomer, as the true ticks are parasitic mites, eight-legged creatures belonging to the class Arachnida, which includes spiders and scorpions. The sheep-tick is six-legged, and is, of course, a true insect, being, in fact, merely a much modified fly. Its scientific name is *Melophagus ovinus*. It is a most repulsive-looking creature of a dark brown colour, about three-sixteenths of an inch long, and is a common pest of sheep, to the fleece of which it clings with extraordinary tenacity so as to be difficult to remove, while, at the same time, it is able readily to work its way hither and thither amongst the compact mass of hairs and so elude pursuit. It has


a

FIG. 5.—Sheep-tick (*Melophagus ovinus*); *a*, claw of ditto, much magnified.

absolutely no wings, and at first sight it appears to have no head; but this is because the head is completely sunk in the thorax, so that there is no constriction between the two, nothing in the nature of a neck. In this feature it departs very widely from the normal plan of fly structure. The head of a fly is usually attached to the body by so slight and narrow a junction, that it can be partially revolved round its pivot from side to side, and a mere jarring is sometimes enough to decapitate a dried specimen; this the dipterist often finds out to his cost, for a collection of flies, unless most carefully kept, is pretty sure to suffer more or less loss from the accidental decapitation of specimens. But no such calamity could ever befall a sheep-tick.

As in all these "louse-flies," the abdomen looks like a more or less flattened bag and shows no trace of segmentation, and its peculiar construction is associated with one of the most remarkable characteristics of these in other respects equally extraordinary creatures. There are several members of the order Diptera, such as the flesh flies for example, that retain their eggs long enough within the parent's body for them to hatch, and hence the young are produced in the form of maggots. But this sheep-tick, as well as the other louse-flies already described, carries this peculiarity still further, and the birth of the young is delayed, not merely till they cease to be eggs and are hatched into maggots, but even until they have passed through their whole larval life and are just on the point of becoming pupæ. While within the maternal body these larvæ are nourished by a sort of milky secretion furnished by the parent. The so-called eggs that the fly produces, therefore, are not really eggs at all, but consist of what in flies is called a "puparium," *i.e.*, a case composed of the last larval skin, containing within it the true pupa or chrysalis. These pupæ are of course very large, and one of them is enough to occupy all the available space in the fly's body, and therefore, necessarily, at each birth the insect's progeny is restricted to a single individual. Of course, the size of these so-called "eggs" would alone be sufficient indication that when thus named they are miscalled. From the peculiar method of their reproduction, this particular group of flies is sometimes called the Pupipara, or pupa-producers.

It might have been supposed that in the sheep-tick these parasitic Diptera had reached the lowest depth of degradation and achieved the maximum of modification, but such is not the case; there are other species that exhibit a still more modified and degraded form, and are thus still more unlike what one ordinarily understands by the word "fly." First there are the so-called Spider-flies or Bat-lice, belonging to the genus *Nycteribia*. They are little creatures, only about $\frac{1}{8}$ of an inch long, of very active and agile habits, living parasitically on bats. The head is reduced to a rudimentary condition, and what little there is left of it is sunk deeply in the thorax, so that the insect appears to begin with its first pair of legs. They are quite wingless and look more like small spiders than flies. Still smaller, more rudimentary, and less fly-like is the little *Braula*, or bee-louse, a parasite on bees.

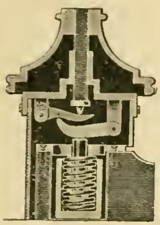
From what has been said above, it will incidentally have become manifest that vertebrate animals are subject to the attacks of at least six distinct sets of parasites of quite different types, the popular names for which are more or less confused, and do not always truly represent the zoological position of the animals, so that such words as lice, ticks, &c., by themselves are but vague, and convey little more distinct idea than that of parasitism. Best known are the fleas, an aberrant group of dipterous insects, and the bugs, belonging to the Hemiptera. Then there are the true lice, with suctorial mouth, which may perhaps be regarded as degraded Hemiptera; the true bird-lice, or Mallophaga, with biting mouths; the Pupipara, or so-called spider-flies, bird-flies, bird-lice, bat-lice, or louse-flies, a parasitic section of the Diptera; and lastly the ticks, or *Ixodidæ*, which are not insects at all, but are allied to the mites and spiders in the class Arachnida. Even these six groups do not exhaust the list of those persecutors of vertebrate animals that actually take up their residence upon the bodies of their victims, though they are all that happen to have occurred to us in our investigations thus far.

Conducted by M. I. CROSS.

POND-LIFE COLLECTING IN NOVEMBER.—With the advent of November, Pond-life all round becomes less abundant, and fewer species are to be met with. By degrees many of the water-plants die down, and the fauna is reduced to such forms as can subsist through the winter. Those animals which cannot do this, such as Polyzoa, Daphnia, some Rotifera, etc., have by this time produced so-called winter eggs or resting germs. The winter fauna, however, is much more numerous than is usually assumed. Among Rotifers, several species of *Synchæta*, *S. pectinata*, *tremula* and *oblonga*, seem to like the winter quite as well as the summer; then the following may also be expected in moderate numbers: *Asplanchna priodonta*, *Anuræa aculeata*, *Polyarthra platyptera*, *Rotifer vulgaris*, *Euchlanis deflexa*, *Triarthra longiseta*, *Brachionus angularis*, *Conochilus unicornis*, *Diglena forcipata*, *Diaschiza lacinulata* and *ramphigera*, *Dinocharis tetractis*, and others. Among the Infusoria, the Vorticella in particular seem to like the cold season, and a number of different species, and often large colonies, can be found attached to submerged rootlets of trees growing near the edge of the water. Attached to the fine stems of *Carchesium*, *Zoothamnium* and other stalked colonies of Vorticella, the very much more minute, but beautiful, colonies of Collared Monads: *Codosiga*, etc., are often found, and deserve a good look with the higher powers.

In canals and lakes where Cristatella has been abundant during the summer, their spiny stadoblast may now be found liberated and often in large masses floating near the edge of the water which lies opposite to the direction of the prevailing wind. These should be collected and placed in a jar full of water with some Anacharis in the warm room at home, where they will hatch by the end of December or January, and the beautiful young Polyzoa can be seen emerging from their box-shaped prison.

Fine Adjustments.—In a former number (July, 1901) some fine adjustments of recent construction were described, and reference was made to one which Messrs. Swift & Son were introducing, the details of which, at the time, were not ready for publication.



The adjoining figure will enable the principles of its construction to be at once appreciated, its action depending on a lever of the second order, which communicates an exceedingly slow rate of movement, and at the same time allows of the use of a coarse operating screw, which obviously would not be so liable to wear with constant use as a fine one.

A fine adjustment of this description goes a long way to elevating a microscope from a tool which magnifies to an instrument of precision, and is a feature which, there is no doubt, will bring its proper reward to its inventors.

While on the subject of fine adjustments, a new two-speed arrangement may be incidentally referred to. Descriptions have previously appeared in these columns of the original device which was introduced by Messrs. R. & J. Beck, and now an altogether different one, possessing novel features, has been put on the market by Messrs. W. Watson & Sons.

In Messrs. Beck's form, the two milled heads were mounted on one centre, *i.e.*, one operated through the other; in Messrs. Watson's form their ordinary lever is used, and for the extra slow movement a second lever is joined to the main one, and acts in conjunction with it, a second milled head separately mounted being fitted for effecting the movement. In effect, the operation of the second lever is the same as an extra long lever would produce.

Considerable limits in the rate of movement are possible by merely altering the pitch of the thread or the point of contact with the lever. In any case it is worthy of notice as a new device in microscopic adjustments.

Cellular Structure.—The interest and information which arise from the examination of cell structures and contents is such as to make it worth while for the ordinary worker to pursue the subject in some degree for himself. Who has not been struck on examining chlorophyll or protoplasmic structure for the first time? and the interest is materially increased by the knowledge of the controversies which have occurred, and experiments which have been made for so many years in connection with this particular subject.

A simple method of examining for oneself is as follows: Take an onion, cut it in half and separate the layers with a pair of forceps; clinging to each scale is a delicate vegetable membrane. This is carefully removed and a piece cut from it with a pair of scissors, about $\frac{3}{8}$ of an inch diameter. This will then have to go through a fixative of 30 per cent. alcohol, in which it is immersed for about three minutes. The fixed specimen is then transferred to a 1 per cent. watery solution of iodine for five minutes. This stains the nucleoli, nuclei, protoplasm and cell-walls a yellow or brown. The specimen is subsequently rinsed and mounted.

If the protoplasm in the cell is to be the special object of examination, some of the fixed pieces should be placed for five minutes in an 80 per cent. solution of alcohol, then transferred to a 1 per cent. aqueous solution of methyl violet for three minutes. This will produce a violet staining effect, which will show not only the cell-wall, nucleus and nucleolus, but also the protoplasm as a distinct mass with a clear space between it and the cell-wall.

If it is desired to double stain the sections, they should be transferred from the fixing solution to Delafield's hæmatoxylin for ten minutes, rinsed in water, then placed in hydrochloric acid 10 drops, water 100cc., in which they should remain until they fade to a salmon pink colour; transfer to water until they assume a light blue colour, immerse in a 1 per cent. aqueous solution of eosin for $\frac{1}{2}$ minute, rinse and mount. These processes produce a nucleus stained a rich blue and other structures pink.

The subject may also be examined fresh in water on a slide having an excavated centre, when the nuclei and cell-walls will appear in faint outline.

Wanted, a Microscope Table.—There are a large number of working microscopists who are greatly restricted for space, and are consequently unable to devote a room for their work, or even to have many really essential fittings. To such, a table which would at once combine and afford all the convenience for microscopical work would be a boon. Medical men nowadays especially have frequently to prepare specimens of sputum and other micro. subjects for immediate examination, and, under ordinary circumstances, each individual item of the various processes has to be specially looked out, the microscope set up and arranged, all at the cost of considerable time and trouble.

Many amateur microscopists would work a great deal more with their instruments if it were not for the trouble of having to look everything out and prepare it for working, this alone often occupies as long or longer than the time at disposal for actual work.

What is wanted, therefore, is a table which shall permit of the microscope being left in readiness for work, and so arranged that either daylight or artificial light may be immediately available. There should be suitable drawers or fittings for lenses, condensers and micro. accessories; proper fittings for re-agents, wash-bottles, troughs, etc.; drawers for mounted specimens, and in addition a space which shall be dust-proof, but not air-proof. In addition, if some convenient device could be suggested for having a supply of water, together with a small basin or sink, the convenience would be increased.

It may be that many readers have given thought to such a matter as this, or may be disposed to do so. I should be glad to receive suggestions or drawings of a comprehensive table, and would arrange that two or three were published in these columns.

Seeing that photo-micrography has now become so much a part of a microscopist's equipment, the desirability of including space for a camera, etc., in connection with the table might also be considered.

Covers for Micro. Specimens, etc.—I am indebted to a reader for kindly sending to me a sample of a very neat cover, which would, I believe, be found advantageous to many working microscopists. This particular one is sufficient in size to cover a 3 by 1-inch slip, and is of the kind used by watch-makers for protecting their work; larger and smaller sizes can be obtained.

In the workroom one is constantly wanting something of the kind for protecting watch glasses, dissecting dishes, staining cells, and preparations generally; this would just seem to meet the need. It has the special advantage of being ornamental as well as useful, the handle being of cut glass of very neat design.

The sender of this states that this was obtained from a wholesale watchmaker in Clerkenwell.

NOTES AND QUERIES.

C. S. T.—The most likely people to give you information as to the various materials for grinding rocks are Messrs. Cotton & Johnson, 14, Gerrard Street, Soho, W. Have you tried Carborundrum?

W. P. B.—The best book on the microscope is "The Microscope and its Revelations," edited by Dr. Dallinger, of which a new edition has recently been published. Of the simpler and more elementary works, "A Popular Handbook to the Microscope," by Lewis Wright, costing 2s. 6d., is very good. To use your Student's Petrological Microscope for general purposes, it is only necessary to withdraw the analyser prism, Bertrand's lens, etc., from the body, and substitute for the polariser an achromatic condenser.

W. F. S.—If you succeed in using your achromatic condenser satisfactorily with the limited means at your disposal, it can only be at the cost of infinite care and patience. It must be recognised that to use a condenser of large aperture efficiently it requires as much care in adjusting as an objective of large aperture. You ought, therefore, to provide yourself with a rack-work focussing substage, with centreing screws to make the condenser quite true with the objective; a simple sliding tube is really not enough for good work.

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.

PERRINE'S COMET (1902 B).—This object was very favourably visible when near the zenith in the clear moonless evenings during the early part of October, but, though pretty conspicuous to the naked eye, it never developed into a really large and imposing comet. Rapidly traversing a path which successively carried it through the stars of Perseus, Cassiopeia, Cepheus, and Cygnus, and thence to the S.W., it entered the equatorial constellation Ophiuchus on about October 17th. On November 1st the comet will be situated about 43° east of the sun, and will set about 3½ hours after that luminary. About an hour after sunset the comet will be placed some 23° above the S.W horizon, and may be found 4° N.W. of the star μ Ophiuchi (mag. 4·7). On November 3rd the object must be looked for 4° W. of the star. On November 9th it will be seen about 5° N. of η Ophiuchi (mag. 2·6). The comet will exhibit a perceptible decline in brightness from night to night (while its apparent motion in the firmament will become markedly slower), so that when moonlight strongly interferes with observation after the first week in November, it will practically disappear as a suitable object for ordinary telescopes.

FALL OF A METEORITE IN IRELAND.—On September 13th, at about 10.30 a.m, some men at Crosskill, Crumlin, Co. Antrim, were working in a field when they heard a noise caused apparently by some explosion, and this was succeeded by a sound similar to that of escaping steam, or a train on the line, only much louder. On looking in the direction from whence the sound proceeded, the men saw something descending with lightning speed into the wheat field adjoining, and portions of the soil were thrown up a considerable distance into the air. Mr. Andrew Walker, on whose farm the meteorite alighted, says it fell vertically, for it made a perpendicular hole, and the corn standing round was not disarranged in any way. The stone was quite hot when taken from the hole about a foot and a half below the surface. It was an irregularly shaped mass of a dark metallic colour, slightly tinged with something like gold. There was a piece broken off, apparently at an earlier date, and was about nine and a half pounds in weight. It was cracked, probably by contact with a large field stone which it met with on embedding itself in the soil. Mr. L. Fletcher, of South Kensington, visited the spot, and purchased the meteorite for the British Museum, so that we may expect to hear more particulars of the interesting phenomenon.

FIREBALLS.—These brilliant objects were very numerous in August and September, and the following are brief references to a few of the most important:—

August 20, 10h. 31m., G.M.T.—Fireball lit up the sky with a glare which dimmed the light of the full moon. Path from 245° + 22° to 210° + 12°. Duration, three seconds.—Rev. W. F. A. Ellison, Enniscorthy.

August 22, 6h. 35m. Large meteor as bright as the moon seen at Trinidad, W. Indies. It appeared in Capricornus, and shot to Coma Berenices.—Newspaper account.

August 24, 7h. 0m.—Brilliant meteor observed at Colombo, passing from N. to S., and bursting into a blaze of light. The dazzling flash terrified the natives, and served to enhance the apprehension regarding the earthquake and similar disasters prophesied by Indian astrologers for the end of the month.—Newspaper account.

August 25, 10h. 31m.—Fine meteor exceeding the lustre of Venus. Path from about 260° + 83° to 163° + 43°. Duration 2·1 seconds.—T. W. Backhouse, Seaton Carew, near West Hartlepool.

August 26, 15h. 13m.—Fireball brighter than Venus shot from 305° + 40° to 290° + 15°, and left a streak for 1½ minutes.—G. M. Knight, London.

September 6, 8h. 30m.—A magnificent meteor seen from the English Channel, London, and Shropshire, but not very exactly recorded.

September 12, 13h. 47½m.—Meteor equal to Sirius soared slowly across the southern sky, traversing a path of about 45° in 3½ seconds. Position 350° + 30½° to 306° + 18°, and radiant near the eastern horizon between 93° + 2° and 103° − 5°.—Prof A. S. Herschel, Slough.

September 19, 10h.—Remarkably large meteor appeared in the N.W., not very far above the horizon, and remained visible about half a minute. It had a pear-shaped head, and fell almost vertically.—The Hon. Cordelia Leigh, Kenilworth.

September 25, 7h. 35m.—Brilliant flashing fireball observed by the Rev. W. F. A. Ellison, Enniscorthy, and also by the writer at Bristol. The former recorded the path as from 340° + 31° to 356° + 17°, while the latter gave it 211° + 41° to 204° + 38½°. The radiant was at 255° + 46°, and the height of the meteor 88 to 57 miles over the sea, between Cardigan Bay and the St. George's Channel. The length of the luminous course was about 34 miles, which it must have traversed with very exceptional velocity, for Mr. Ellison estimated the duration of flight as certainly not more than one-eighth of a second! At Bristol the actual descent of the meteor was not seen, but the flash caused the observer to look upwards, and the path was recorded by the transient streak.

September 27, 7h. 42m.—Large meteor brighter than Venus, seen by Rev. W. F. A. Ellison, at Enniscorthy, moving from 290° + 3° to 298° − 7°, and lighting up the country. Duration 1½ seconds. This object was also observed by Mr. A. Sullivan, of Dundrum, Co. Dublin, with a path from ϵ Aquari to within half a degree of Jupiter.

THE FACE OF THE SKY FOR NOVEMBER.

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

THE SUN.—On the 1st the sun rises at 6.54 and sets at 4.33; on the 30th he rises at 7.43 and sets at 3.54. The equation of time is at maximum on the 3rd, when the sun is 16m. 20s. before the clock.

Sunspots may be looked for.

THE MOON:—

	Phases.	h. m.
Nov. 8	☽ First Quarter	0 31 P.M.
,, 15	○ Full Moon	5 7 P.M.
,, 22	☾ Last Quarter	7 47 A.M.
,, 30	● New Moon	2 4 A.M.

The moon is in apogee on the 5th, and in perigee on the 17th.

The following are among the more interesting occultations visible at Greenwich:—

Date.	Star Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
			h. m.	°	°	h. m.	°	°	d. h.
Nov. 9	B. A. C 7717	6·5	5 33 P.M.	47	61	6 49 P.M.	256	267	9 10
,, 21	60 Cancri	5·7	0 6 A.M.	94	134	1 7 A.M.	291	328	20 17
,, 24	υ Leonis	4·5	2 14 A.M.	69	107	3 0 A.M.	333	9	23 19

THE PLANETS.—Mercury is a morning star, and is near α Libræ on the 20th. He attains his greatest westerly elongation of 18° 50′ on the 4th, when he rises about 5 A.M., the diameter of the planet is then 6″·8.

Venus is practically unobservable, being in superior conjunction with the sun on the 29th.

Mars is becoming more conveniently observable. About the middle of the month the planet rises half-an-hour after midnight and his path is situated in Leo. On the 17th he will appear in the same field of view as the fourth magnitude star χ Leonis. The diameter of the planet is increasing, being now about 5″·5, whilst 0·91 of his disc appears illuminated.

Jupiter can be observed during the early part of the evening; at the beginning and end of the month he is on the meridian at 6.5 P.M. and 4.26 P.M., and is therefore most suitable for observation as soon as it is dark; on the same dates he sets about 10.30 P.M. and 9 P.M. respectively. His polar diameter is diminishing, being 37″ on the 1st and 34″ on the 30th. He is in quadrature with the sun on the 2nd at 2 A.M.

The following are among the more interesting of the satellite phenomena visible at Greenwich:—

Day.		H. M. P.M.	Day.		H. M. P.M.
Nov. 6.	I. Sh. I. ..	5 18	Nov. 21.	I. Oc. D. ...	5 11
	I. Tr. E. ...	6 18		I. Ec. R. ...	8 45
	I. Sh. E. ...	7 38		IV. Ec. D. ...	8 56
	III. Oc. R. ...	7 46	„ 28.	II. Sh. I. ..	4 49
	III. Ec. D. ...	9 32		II. Tr. E. ...	5 15
„ 13.	IV. Sh. E. ...	5 39		I. Oc. D. ...	7 10
	I. Tr. I. ...	5 55		II. Sh. E. ...	7 44
	I. Sh. I. ...	7 14	„ 29.	I. Sh. I. ...	5 34
	III. Oc. D. ...	8 10		I. Tr. E. ...	6 42
	I. Tr. E. ...	8 15		IV. Tr. I ...	7 43
	I. Sh. E. ...	9 34		I. Sh. E. ...	7 55
„ 21.	II. Sh. E. ..	5 8			

Saturn is an evening star, setting on the 1st about 9 P.M., and on the 30th about 7.30 P.M. The best time for observing the planet is during the earlier part of the month immediately after dark. The ring is widely open and northern surface visible On the 6th of the month Saturn is in conjunction with the moon at 5 P.M.; the planet being $5\frac{1}{2}°$ to the south.

Uranus is approaching conjunction with the sun and cannot be observed.

Neptune is well placed throughout the month, rising on the 15th about 7 P.M. The planet is still close to μ Geminorum, and may be seen in the same field of view with a low power. On the 1st their respective positions are:—

	R. A.	Declination.
Neptune ...	6h. 15m. 22s.	N. 22° 16′.
μ Geminorum	6h. 17m. 6s.	N. 22° 34′.

The Stars.—About 9 P.M. at the middle of the month, the following constellations may be observed:—

Zenith . Cassiopeia.

South . Andromeda, Pisces, Cetus; Pegasus, Aquarius towards S.W.

West . Aquila, Cygnus, Lyra a little north of west, Corona N.W., setting.

East . Auriga, Perseus, Pleiades, Taurus; Aries to the S.E.; Orion rising S.E.

North . Ursa Major, Ursa Minor, Cepheus; Draco a little west of north.

Minima of Algol will occur on the 5th at 9.55 P.M., 8th at 6.44 P.M., 25th at 11 38 P.M., 28th at 8.26 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. 16.

Key-move.—1. Kt to B4.

If 1. . . . Q × B, 2. R to K5ch, etc.
1. . . . Q to B3, 2. Q × BP, etc.
1. . . . Kt to R3, 2. R × Q. etc.
1. . . . Q to K3, 2. R × Q, etc.
1. . . . P to Kt4, etc., 2. Q to B7ch, etc.

[There are duals after Q × R, by 2. Q to B7ch, or 2. Q × KtPch; after K × R, by 2. Q × BPch, or 2. Q to Kt6ch; after Q to Kt2, by 2. Q × BP, or 2 Q to B7ch; after Kt to B3, by 2. Q × KtPch, or 2. R × Q; after P to Kt3, by 2 Q to B7ch, or R × Q. There is also a triple continuation after Q to Q3, and a quadruple after Q to Ksq. Evidently some of these might have been stopped.]

No. 17.

Key-move.—1. R to Kt4.

If 1. . . . K to K2, 2. Kt to B8ch, etc.
1. . . . K to K4, 2. B to B4ch, etc.
1. . . . B to Kt2, 2. Q to Rsq. ch, etc.

[The same applies to 1. . . . P × R and R × KtP, etc. with varying mates.]

1. . . R × Q, 2. Kt to Q5ch, etc.
1. . . . R × BP, 2. Q × R (R4) ch etc.

[After P × P and other moves, there is a dual by 2. Q to Rsq. ch, or 2. Kt to Q5ch; and after R to Kt6 a triple, by the same two moves and 2 Q × Rch.]

No. 18.

Key-move.—1 R to K6.

If 1. . . . QP × R, 2. Q × Pch, etc.
1. . . . P to Q3, 2 R × Pch, etc.
1. . . . K × R, 2. Q to B6ch, etc.
1. . . . B to Kt4, 2. R × Bch, etc.
1. . . . R to R2, 2. B × P, etc.
1. . . . Others, 2. Q × B, etc.

After some hesitation I have come to the conclusion that a solver cannot score points for a triple, quadruple, etc., when he has already scored them for a dual in which *any two* of the continuations occur. For example, the triple in No. 17 is in reality only a repeated dual, with an additional continuation thrown in. It cannot score, therefore, for a solver who has already scored for the dual. So also the triple in No. 16 does not score for those who have claimed the duals after Q × R and Q to Kt2; while the quadruple would not score when any other dual has been claimed, except that after K × R.

Solutions received from W. Nash, 8, 5, 3; "Alpha," 4, 0, 0; W. Jay, 9, 5, 4; G. Woodcock, 5, 4, 4; "Tamen," 8, 4, 4; C. Johnston, 6, 5, 4; "Looker-on," 9, 5, 4; J. W. Dawson, 6, 4, 4; Lt.-Colonel Damania, 4, 4, 4.

W. Nash.—The dual claimed in No. 18 does not appear to be correct, *e g.*, 1. . . . P to Kt4; 2. R × R, P × R; 3. (?). Your claim in No. 16, after "P moves," was also incorrect, but as you distinctly stated that you claimed nothing for it, I have been able to deduct nothing.

"*Tamen.*"—Both your letters bore the correct post-mark this time.

J. W. Dawson.—Your claim for dual in No. 17 after 1. . . . B to K7, by R × P, etc., does not appear to be correct. Black replies 2. . . . R × KtP or B to Kt2. Certainly a composer may vote for his own problem, and place it wherever he thinks fit; and such vote will carry equal weight with others. This, in fact, is a necessity, as the composers of the problems will not be known to me till some time later.

Lt.-Col. Damania.—Key-moves only are preferred, but during the progress of the Problem Tourney points are being awarded for duals on the second move.

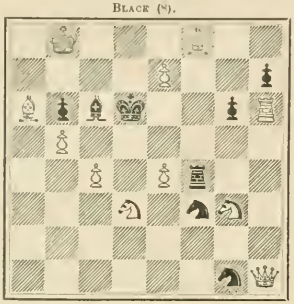
G. W. Middleton.—I regret to receive no solutions from you this month; more especially as I had hoped to have you on the "jury" at the end of the year.

PROBLEMS.

No. 19.

"Circumstances alter cases."

BLACK (8).



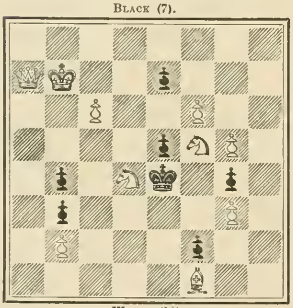
WHITE (11).

White mates in three moves.

No. 20.

"All's well that ends well."

BLACK (7).



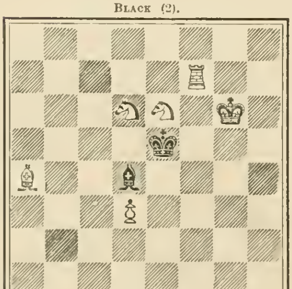
WHITE (10).

White mates in three moves.

No. 21.

"True Blue."

BLACK (2).



WHITE (6).

White mates in three moves.

The scores of the six leaders in the Solution Tourney are now as follows:—

W. Jay	89	J. W. Dawson ..	72
"Looker-on" ...	84	C. Johnston ...	71
W. Nash ...	83	G. Woodcock .	66

Mr. Jay has increased his lead and should be difficult to overtake; but there will at any rate be a desperate struggle for second and third prizes. I sincerely hope that none of the above will retire before the *end* of January, when the last Tourney Problem will have appeared. Otherwise the number of the jury will indeed be limited, the above six alone being now eligible to serve. The Solution Tourney, of course, ends with the problems published in the December number.

I am unable to find the problem "Aller guten Dinge sind drei." The sealed envelope is also missing, and it is not likely that both can have been mislaid. I can only guess, therefore, in the absence of evidence to the contrary, that the composer must, some months ago, have withdrawn the problem, and that the fact has escaped my memory. Should the composer see this, I trust that he will let me know the facts.

CHESS INTELLIGENCE.

Mr. F. J. Marshall has recently defeated Mr. R. Teichmann in a short series of games, winning two and drawing the other three. A small tournament in Paris resulted in the following score:—D. Janowski, $4\frac{1}{2}$; S. Taubenhaus, $3\frac{1}{2}$; Von Scheve, 3; A. Albin, $\frac{1}{2}$.

Two eminent chess masters have passed away during the last month. One, M. Rosenthal, was for many years the best player in France, eminent alike as a theorist and a practical player. He is chiefly remembered in England for his game against Steinitz, which won the brilliancy prize in the London Tournament of 1883. The other, C. A. Walbrodt, of Berlin, was an even stronger player. He did not do himself justice in the Hastings Tourney, but at his best he was probably among the first six European players. His death occurred at the age of 31.

All manuscripts should be addressed to the Editors of KNOWLEDGE, 326, High Holborn, London; they should be easily legible or typewritten. All diagrams or drawings intended for reproduction, should be made in a good black medium on white card. While happy to consider unsolicited contributions, which should be accompanied by a stamped and addressed envelope, the Editors cannot be responsible for the loss of any MS. submitted, or for delay in its return, although every care will be taken of those sent.

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CONTENTS.

EDITORIAL.

With this number the Twenty-fifth Volume of Knowledge is completed. At the close of a year the mind travels naturally back over events and attainments of the past, and the student, old or young, is inclined to raise enquiring eyes from his own occupation to contemplate progress around him.

The certainty of steady progress in science will be felt after such a survey of the year 1902; and if war gives rise to many opportunities for bringing the man of science to the front, at least we may express the conviction that peace following strife gives to science an impetus towards solid advancement. Should Knowledge in any sense have led its readers during the past year to a participation in the results of the progress of science, the Editors and Contributors alike can be but gratified.

We hope that those of our readers who incline to natural science will allow us to remind them that at no time before has the study of nature been considered so essential a part of life as at the present, whether undertaken as the pursuit of spare moments or as the serious profession of every day.

As regards our arrangements for 1903; in Astronomy Mr. A. Fowler will write a series of papers on Spectroscopic subjects, while Mr. Maunder, having now completed his articles on "Astronomy without a Telescope," will devote himself during the year to the discussion of subjects of current interest. Miss A. M. Clerke will deal with some "Theories of Gravitation," giving an account of the most recent speculations or discoveries regarding the mode of action by which the planetary and sidereal machines are kept going. Miss Clerke will also discuss some new views in Solar Physics. We hope to publish early in the year some photographs of Perrine's Comet, by Dr. Isaac Roberts, and articles on the Path of the Moon, by Mr. A. C. D. Crommelin, and on Stellar Satellites by Mr. J. E. Gore.

The column devoted to Comets and Meteors will be continued by Mr. W. F. Denning; while "The Face of the Sky" will still be in the hands of Mr. W. Shackleton, who proposes to aid the observer by additional diagrams.

Mr. R. Lloyd Praeger promises a set of articles on Familiar British Wild Flowers and their Allies. The extent, distribution, and character of various orders of plants will be dealt with, particular reference being made to the British species and the points of interest connected with them.

Mr. F. Enock regrets that he has been unable so far to keep his promise of contributing some life-histories of the insects, to the study of which he has devoted so many years, but he will redeem his promise during 1903.

Amongst other contributors we may mention that Mr. J. Collier proposes to write some papers on Sociology; Mr. Pycraft will supply some illustrated papers on "Wind Bags and their Uses in various Birds and Fishes"; Mr. D. Wilson-Barker hopes to tell us more about the Clouds, which he photographs so cleverly; and Mons. E. M. Antoniadi has prepared some very fully illustrated articles on S. Sophia, the structure and history of which he has studied very closely.

Mr. M. I. Cross will continue to conduct the Microscopical section, to which it is proposed to allot more space in order to provide for a programme which is fully set out under the Microscopical heading in this issue. In this connection Mr. Cross has already secured the assistance of such well-known workers as Messrs. Noad Clark, Earland, Rousselet, Sanger Shepherd, Soar, and Wesché.

A new Chess Solution Tourney for possession of the Knowledge Challenge Trophy will begin with the problems in the January number.

THE ERUPTIONS IN THE WEST INDIES.

Soon after the great eruptions in Martinique and St. Vincent last May, the Royal Society appointed a small commission to investigate the phenomena in both islands, and especially in St. Vincent. Dr. Tempest Anderson, a well-known student and photographer of volcanoes, and Dr. John S. Flett, of H.M. Geological Survey, left London on May 28th. They arrived at Barbadoes on June 8th, and proceeded to St. Vincent, where nearly four weeks were spent, chiefly at Chateaubelair and Georgetown, in the neighbourhood of the Soufrière. Early in July they visited Martinique for six days, in order to ascertain the general points of difference and similarity between the outbursts of Mont Pelée and the Soufrière, the phenomena in this island being studied by a French scientific commission under the directorship of Prof. Lacroix. On their return to England, a preliminary report was presented to the Royal Society, and was printed immediately in the *Proceedings*. As some time must elapse before the complete report is published, we give here a summary of this first paper, quoting fully from the interesting account of the eruption of Mont Pelée observed by the commission on July 9th.

THE ERUPTION OF THE SOUFRIÈRE.

The island of St. Vincent is oval in form, eighteen miles long from north to south, and eleven miles broad. The main axis is occupied by a mountain chain, composed entirely of volcanic materials. In the south of the island volcanic action has long been extinct or dormant, but at the north end stands the still active Soufrière. This mountain, which is 4048 feet in height, is a simple cone like Vesuvius, without lateral or parasitic craters. Its principal crater, known as the Old Crater, is nearly circular in form. Before the recent eruption, it was nine-tenths of a mile across, and about 1100 feet deep. The bottom was occupied by a lake, said to have been over 500 feet deep. On its north-east lip is a smaller crater, one-third of a mile in diameter, called the New Crater, as it is supposed to have originated in the eruption of 1812. The remains of a gigantic crater-ring surround the cone on its north side, bearing the same relation to it that Somma does to Vesuvius. Deep valleys have been cut in the slopes of the mountain, especially on its southern side; and it is in these that the greater part of the ejecta of the recent eruption have collected.

For more than a year before the eruption took place, the north part of the island was subject to frequent violent earthquakes; and, as far back as February, 1901, two settlements of the aboriginal Caribs were considering the advisability of deserting the district. About midday on Tuesday, May 6th, the first signs of the eruption were observed by residents on the south-west side of the mountain. At 2.40 p.m. there was a considerable explosion, and a large cloud of steam ascended into the air; at 5 p.m. a red glare was visible in the steam cloud on the summit; at midnight there was a great outburst, and red flames were noticed on the lip of the crater. Next morning gigantic mushroom-shaped clouds could be seen rising to a height of about 30,000 feet, and drifting away before the north-east trade wind. As the day advanced, the eruption increased in violence; by 10.30 a.m. enormous clouds of vapour were being emitted with loud noises, accompanied by much lightning; and it could be seen that the materials were mostly, if not entirely, discharged from the Old Crater. The activity now became continuous; huge columns of vapour ascended with frequent violent outbursts, projecting showers of stones and mud on all sides, and chiefly to the east. At midday on Wednesday, May 7th, the slopes of the mountain were still green, though a layer of fine ash, just sufficient to give the leaves a greyish colour, had fallen over the lower ground.

About this time, it was noticed that steam was rising from some of the valleys on the south side of the mountain. Soon afterwards, the Rivers Wallibu and Rabaca on this side were seen rushing down in raging floods of boiling water, and the whole mountain became enveloped

Fig. 1.—Mount Pelée from the West.

in a dense cloud of vapour. The crater lake seems to have been driven over the lower or south lip of the crater, and to have poured down the valleys as a tremendous rush of boiling water to the sea.

It is remarkable that, so far, the inhabitants on the east or windward side of the island had not realised their danger. As is frequently the case, the summit on this side was wrapped in cloud. Even on the morning of Wednesday, May 7th, sugar-making was in progress on several estates. By midday, however, all were convinced that the noises heard continuously were not due to a thunderstorm; but it was then too late to escape, for the Rabaca and other streams, usually dry except after rains, were running boiling hot and could not be crossed. It was here that the loss of life was greatest, the number of persons killed being estimated roughly at 2000, including about a dozen white men. On the opposite side of the island the loss was comparatively small. The view of the crater was clear, and the early outbursts of steam gave ample warning to the inhabitants, who fled along the coast to Chateaubelair and other places to the south.

To return to the eruption. At 1 p.m. the roaring of the volcano was tremendous, and after the large outbursts, which took place every few minutes, volumes of vapour might be seen covering the whole area. So far, there was nothing abnormal in the eruption, and the destruction was confined to the higher parts of the mountain.

But about 2 p.m. there was a rumbling and a large black outburst with showers of stones. A strange black cloud, laden with hot dust, swept down the mountain side burying the country in hot sand, suffocating and burning all living creatures in its path, and devouring the rich vegetation of the hill with one burning blast. On the west coast most of the inhabitants had escaped, but a few persons overtaken by the black cloud were killed or badly burned. One boat was near Richmond at the time the blast swept down. The heat is described as fearful. Hot sand rained into the boat, and the sea around was hissing with its heat. The darkness was so intense that a man could not see his hand. On the east side of the island, a dense black cloud was seen rolling with terrific velocity down the mountain side towards the sea, flashing with lightning, especially when it touched the water. All survivors state that it was intensely hot, and was charged with hot dust, and that it smelt strongly of sulphur. They felt as if something was compressing their throats, and as if there was no air to breathe. The suffocating cloud only lasted a few minutes, and by the time it had reached the coast, the sand it contained, though still at a very high temperature, did not set fire to wood or burn the clothes of those exposed to it. At some distance from the cloud, one observer describes it as "a solid black wall of smoke falling into the sea about two or three miles from us. It looked like a promontory of solid land, but it rolled and tumbled and spread itself out until in a little time it extended quite eight miles over the sea to the west. . . . Then began the most gorgeous display of lightning one could conceive. . . . It was still bright daylight, but the whole atmosphere quivered and thundered with wavy lines intersecting one another like trellis-work. We were encircled in a ring of fiery bayonets."

Intense darkness now covered the whole north end of St. Vincent. The roaring of the mountain was terrible. Fine ash and sand rained down over the whole country, with occasional showers of large stones, some of which were so hot as to set fire to the "trash" roofs of huts seven miles from the crater. The eruption in all probability had reassumed the ordinary phase, the showers of ash and stones being produced by violent upward explosions of steam. Shortly before nightfall, the darkness lessened slightly, but the rain of dust and the noises lasted till early on the following morning (May 8th). When day broke, the volcano was still emitting puffs of slaty coloured steam, and showers of fine dust were falling on the west side of the mountain. A week later (May 15th) the volcanic activity had apparently subsided, and the mountain remained clear and unclouded until Sunday, May 18th, when a second but much slighter eruption took place. The noises were as loud as before, the lightning very vivid, and ashes and sand fell freely for some hours. Clouds of steam were sometimes seen gently rising for some days later, but no further outburst took place until after the publication of the preliminary report.

When the English commission arrived in St. Vincent on June 10th, the Soufrière and the surrounding country to the south of Chateaubelair and Georgetown were still covered with a layer of ashes, mostly in the form of a fine sand, mixed with spongy bombs and many ejected blocks composed of fragments of the old rocks of the hill. The latter consist of weathered andesites and andesitic tuffs, such as can be seen in the walls of the crater, some of them being more than five feet across. The larger bombs are often black, highly lustrous, and glassy when broken across. Some seen at Wallibu (four miles from the crater) were three feet in diameter. The sand when dry is yellowish-grey in colour, but when wet becomes almost black. It contains plagioclase felspar, hypersthene, augite, magnetite, and fragments of glass, and represents a fairly well crystallised hypersthene-andesite magma which has been blown to powder by the expansion of occluded steam.

Owing to the heavy tropical rains and the quick growth of vegetation, this deposit was rapidly disappearing. Around Georgetown it was from one to three feet deep, in the Carib country four feet, while on the higher slopes of the hill, where it had gathered in hollows, it reached a depth of from five to over twelve feet. Those who visited the country shortly after the first eruption described it as having a smooth, gently rolling surface like that of blown sand. It is clear that immense quantities of hot sand had rushed down the hill into the valleys in an avalanche which carried with it a terrific blast, and piled the ashes deep in the sheltered ravines, at the same time sweeping everything off the exposed ridges which lay between.

For some days after the eruption the stream valleys were level with their banks. But on May 24 and 25, nearly eight inches of rain fell, and with this the rainy season set in. After a heavy tropical shower, valleys that were usually dry were occupied by a thundering torrent several feet deep and twenty or thirty feet across, that soon swept away the ashes from the upper part of their channels. But in the lower valleys, which had been filled with thick masses of hot sand, the process of removal was still (in the middle of June) going on, and a curious spectacle was seen after every shower. The streams, by undermining their banks, caused land-slides, and when the hot ash fell into the water, columns of muddy water rose to about 200 feet, carrying with them pieces of stone, while immense clouds of steam shot up to heights of 700 or 800 feet, expanding in great globular masses, exactly like the steam explosions from a crater.

When Drs. Anderson and Flett ascended the Soufrière, there was the clearest evidence of the passage of a hot blast laden with sand. Near the shore on the east side, the sugar-cane fields were covered with three or four feet of sand and scoria; the trees were all bare, a few branches broken, but no trees were uprooted or thrown down. At

Fig. 2.—Mont Pelée in eruption on July 9th. (The lighter-coloured cloud on the right is the trade-wind cloud which so constantly covered the summit.)

this point the velocity of the blast was not above that of an ordinary gale, and the dust it carried, though hot, was not incandescent. At an elevation of about 1000 feet, a further stage of devastation was encountered; the fields were swept bare, the trees broken down, though not as a rule uprooted, their smaller branches swept away; a deep layer of black sand covered the crops of sugar-cane. The blast was here a violent gale.

A little further up, enormous trees, even great cotton-trees ten feet or more in diameter, had been uprooted and cast down, the fallen trunks in every case pointing directly away from the crater. The smaller trees were sometimes swept away like straws. Most were charred, some deeply, but, as the wood was green, only the smaller branches had been consumed. The effect was like that produced by a violent hurricane, only more complete, for many of these trees had withstood the hurricane that ruined St. Vincent in 1898. Still higher, or above the 1500 feet level, there was little left of the rich tropical vegetation which had covered the mountain. Blackened remains of tree-trunks were to be seen, overturned or broken off near the ground, and buried in dark sand. The highest parts of the mountain formed as bare and desolate a scene as could be imagined. The ash was five to twelve feet deep, and contained a good deal of burnt timber, utterly blackened and converted into charcoal. Everything was mown down, and there was nothing to show what was the velocity of the blast when it left the crater.

The structural modifications produced upon the mountain were very slight. No fissures were seen, no parasitic craters or cones were formed, and there were no lava streams. Even the craters at the summit retain essentially their old configuration, though the outline of the lip of the crater, as seen from Chateaubelair, has undergone some slight changes, and the southern edge is somewhat lower than it was before the eruption. The inner slopes of the crater, formerly richly wooded, are now naked slopes or precipices of rock. The depth of the crater was generally estimated at about 1600 feet. The bottom, when seen by the English commission, was nearly flat or slightly cup-shaped, and contained three small lakes of greenish and turbid water.

THE ERUPTION OF MONT PELÉE.

Mont Pelée, like the Soufrière, is a simple cone with a large vent near the summit and without parasitic craters. Both mountains are deeply scored with ravines, and on the south-west side of each there is a broad valley, occupied by St. Pierre in the one case, and by the valley of the Wallibu in the other. It is in these valleys that the destruction was most pronounced. In St. Vincent, however, the mass of material ejected and the area devastated were much greater than in Martinique. The loss of life was less, but this was due to the absence of a populous city at the foot of the Soufrière. On Mont Pelée the blast that overwhelmed St. Pierre was emitted from a triangular fissure, which opened on the south side of the mountain; on the Soufrière the blast came from the old orifices. The eruption in Martinique began with the flow of mud lavas, while none such were seen in St. Vincent. These are the chief points of difference between the two eruptions. On the other hand, both were characterised by a complete absence of lava streams and by the paroxysmal discharge of hot sand and dust mingled with a small proportion of bombs and ejected blocks. The hot blast which swept down on St. Pierre was similar to that emitted by the Soufrière.

During their brief sojourn at Martinique, Messrs. Anderson and Flett were fortunate in witnessing one of the more important eruptions of Mont Pelée, evidently a counterpart of that which destroyed St. Pierre. On July 9th, they were near St. Pierre in a small sloop that had been hired for their expeditions. During the morning the volcano was beautifully clear, and only occasional jets of steam rose from the triangular fissure that served as a crater. A little after midday, however, large steam clouds began to rise, one every ten or twenty minutes, with a low rumble. While they rose they expanded, and, as they consisted of many globular rolling masses, they bore some resemblance to a gigantic cauliflower. About half past six it was obvious that the activity of the mountain was increasing. The cauliflower clouds were no longer detached, but arose in such rapid succession that they were blended in a continuous emission. A thick cloud of steam streamed away before the wind, so laden with dust that all the leeward side of the hill and the sea for six miles from the shore were covered with a dense pall of fine falling ash.

"Just before darkness closed in, we noticed a cloud which had in it something peculiar hanging over the lip of the fissure. At first glance it resembled the globular cauliflower masses of steam. It was, however, darker in colour, and did not ascend in the air or float away, but retained its shape, and slowly got larger and larger. After observing it for a short time, we concluded that it was travelling straight down the hill towards us, expanding somewhat as it came, but not rising in the air, only rolling over the surface of the ground. . . . It seemed to take some time to reach the sea (several minutes at least), and as it rolled over the bay we could see that through it there played innumerable lightnings. . . . As the darkness deepened, a dull red reflection was seen in the trade-wind cloud which covered the mountain summit. This became brighter and brighter. . . . Suddenly the whole cloud was brightly illuminated. . . . In an incredibly short space of time a red-hot avalanche swept down to the sea. . . . It was dull red, with a billowy surface, reminding one of a snow avalanche. In it there were larger stones which stood out as streaks of bright red, tumbling down and emitting showers of sparks. In a few minutes it was over. . . . Undoubtedly the velocity was terrific. Had any buildings stood in its path they would have been utterly wiped out, and no living creature could have survived that blast.

"Hardly had its red light faded when a rounded black cloud began to shape itself against the star-lit sky, exactly where the avalanche had been. The pale moonlight shining on it showed us that it was globular, with a bulging surface, covered with rounded protuberant masses, which swelled and multiplied with a terrible energy. It rushed forward over the waters, directly towards us, boiling, and changing its form every instant. In its face there sparkled innumerable lightnings. . . . The cloud itself was black as night, dense and solid, and the flickering lightnings gave it an indescribably venomous appearance. It moved with great velocity, and as it approached it got larger and larger, but it retained its rounded form. It did not spread out laterally, neither did it rise into the air, but swept on over the sea in surging globular masses, coruscating with lightnings. When about a mile from us it was perceptibly slowing down. We then estimated that it was two miles broad, and about one mile high. It began to change its form; fresh protuberances ceased to shoot out or grew but slowly. They were less globular, and the face of the cloud more nearly resembled a black curtain draped in folds. At the same time it became paler and more grey in colour, and for a time the surface shimmered in the moonlight like a piece of silk. The particles of ash were now settling down, and the white steam, freed from entangled dust, was beginning to rise into the air.

"The cloud still travelled forward, but now was mostly steam, and rose from the surface of the sea, passing over our heads in a great tongue-shaped mass, which in a few minutes was directly above us. Then stones, some as large as a chestnut, began to fall on the boat. They were followed by small pellets, which rattled on the deck like a shower of peas. In a minute or two fine grey ash, moist and clinging together in small globules, poured down upon us. After that for some time there was a rain of dry grey ashes. But the cloud had lost most of its solid matter, and as it shot forward over our heads it left us in a stratum of clear pure air."

"The most peculiar feature of these eruptions," write Drs. Anderson and Flett in concluding their report, "is the avalanche of incandescent sand and the great black cloud which accompanies it. The preliminary stages of the eruption, which may occupy a few days or only a few hours, consist of outbursts of steam, fine dust, and stones, and the discharge of the crater lakes as torrents of water or of mud. In them there is nothing unusual, but as soon as the throat of the crater is thoroughly cleared, and the climax of the eruption is reached, a mass of incandescent lava rises and wells over the lip of the crater in the form of an avalanche of red-hot dust. It is a lava blown to pieces by the expansion of the gases it contains. It rushes down the slopes of the hill, carrying with it a terrific blast, which mows down everything in its path. The mixture of dust and gas behaves in many ways like a fluid. The exact chemical composition of these gases remains unsettled. They apparently consist principally of steam and sulphurous acid. There are many reasons which render it unlikely that they contain much oxygen, and they do not support respiration." C. D.

THE DOMESTIC ECONOMY OF THE THRUSH.

As observed by A. H. Machell Cox, m.a.

From an æsthetic point of view never did summer-house less justify its existence than the hideous rectangular erection which disfigured one of the most perfect gardens I have known. There was not the faintest pretence of rusticity about it. Painted a vivid green outside and in, it boasted a door at one end, and glass windows, incapable of being opened on each remaining side. It was a matter for congratulation that such an abominable structure should be partially concealed behind a screen of laurel, box, and holly, and especially so to my mind, because by this means it became converted into a unique post of observation for the prowling naturalist. I soon learnt to appreciate it as such, and one Easter, when I was more or less incapacitated from strenuous exertion by the effects of influenza, I availed myself to the full of the opportunities it offered.

A tour of inspection on April 11th had revealed the nests of two thrushes in the laurels on different sides of the summer-house. One of these was not conveniently placed for close observation, and I will dismiss it with only a word or two. It had been built in evident haste, and the inner lining of mud and decayed wood was so incomplete that the light showed through the whole of one side of the nest. Nevertheless it contained one egg, on which, as is frequently the case, the mother thrush was already sitting for a great part of the day. A second egg and a third were laid on succeeding days, and the clutch appeared to be complete, for these were sat on closely for three full days before a fourth egg made its appearance in the nest. Three of these eggs were eventually hatched on April 28th, and the last on April 29th.

A peculiarity of the second nest was that it had been built upon the remains of a bullfinch's nest of the previous year. There were four eggs which were hatched on April 14th. From that date onwards I spent many an hour in studying the principles of the domestic economy of these birds. It might be supposed by anyone who had not made the experiment that the familiar song-thrush would be a good subject for this purpose, but, as a matter of fact, it is most fidgetty and impatient under scrutiny.

"Being observed," wrote Mrs. Browning, "when observation is not sympathy, is just being tortured"; if this is true of mankind, it may be accepted as an axiom where birds are concerned, and for the most part even without the qualifying clause, for, through no fault of their own, they are slow to recognise sympathy. This, however, was an excellent opportunity for seeing without being seen. The nest was four feet from the ground, and about the same distance from the window; so nothing more was needed than to paste the latter up from inside, leaving a small spyhole. A chair was placed in position, with a small table beside it, on which were my watch and paper and pencil ready for use. By approaching cautiously from the opposite side I generally managed to slip in unobserved, and, once there, I could sit taking copious rough notes with the happy consciousness that, in spite of my startling proximity to the nest, I could breathe freely and make small movements with no fear of betraying my presence. I even removed some of the laurel leaves outside, so that nothing should impede my view.

After a little while I found to my satisfaction that I was able, as a rule, to distinguish the female from the male by the slightly different markings of the throat. The male seemed to do a good share of the work, and he found very little time for singing. Food was brought on an average once every five minutes throughout the day, and there was no perceptible increase in the number of visits as the young became bigger.

By very close watching I satisfied myself as to the impartial distribution of food, though at first sight it seemed to be left entirely to chance. As often as not, at a single visit one hungry mouth was fed, and one only, and not unfrequently this privileged nestling would receive the next supply too. But the pangs of hunger soon restored the balance; those in most immediate need struggled hardest to assert themselves and to gain the best position. All mouths would be opened to the widest extent on the next visit, and the parent without hesitation would deposit the food in that which was readiest to receive it. This primitive arrangement embodies a principle which alone makes it possible to provide for a ravenous brood with the necessary impartiality. Watch an old starling surrounded in the field by her inexperienced family, who press eagerly round her as she probes deep into the ground for a hidden grub; this obtained, she does not dispose of it at once, but dashes off at top speed followed by her youngsters; after running a score of yards she stops abruptly and gives the prize without more ado to the nearest pursuer. The hungriest will have exerted himself the most. It is the same principle, and a fair one on the whole, but what happens when one is more weakly than his fellows from the first?

I must now allude to the sanitary arrangements for keeping the nest clean and habitable. Here I confess my preconceived ideas received a shock, and I made, what was to me, quite a new discovery. For instead of the droppings being removed to a distance by the parents, the latter invariably swallowed them. At first I thought I must be mistaken, but I witnessed it again and again, and the mode of procedure was always the same. A mouth was filled, a parent remained waiting a moment or two on the edge of the nest, and then, after a slight change of position of the young bird, reached down to receive the excrement, which was deliberately eaten. Any delay brought an impatient peck as a reminder; only once did this fail to have the desired effect, and then the omission was rectified on the next visit. These methods were scrupulously adopted by both parents from the very first, and were only discontinued when the young birds left the nest. I may add that a year later I watched just the same proceeding at a mistle-thrush's nest, and I can well believe that the blackbird has a similar habit. Now, at the time I searched all the books available, but failed to find any mention at all of this remarkable fact. Quite recently, however, when looking through some back numbers of Knowledge, I came across a most interesting paragraph on the subject by Mr. H. F. Witherby.* His remarks were based on observations of a mistle-thrush's nest. From this paragraph I learnt that the habit of swallowing the droppings

* *See* Knowledge, 1898, p. 66.

had been described by Mr. Weir in Macgillivray's British Birds. Mr. Weir observed that in the blackbird, song-thrush and mistle-thrush the old birds swallowed nearly all the droppings of their brood. Moreover, he shot one of the birds and found the droppings in its stomach. Since Mr. Witherby's observations the habit has been recorded in these columns by the Rev. A. East* and by Mr. George J. Chapman.† I was particularly interested to find that Mr. Witherby suggested that the parent birds at the time when they are busily occupied with the needs of their hungry offspring, probably derive a considerable amount of their own nourishment in this curious manner. This is just the conclusion I arrived at independently, and I was strengthened in this belief when I observed that the thrushes allowed no time for their own feeding. A great many of the worms that they brought were found close at hand on the lawn in front of me, and from my window I could sometimes keep one bird under perpetual observation for half-an-hour at a time. As a matter of fact I often had my eye at the spy-hole even while I was writing a note for fear of missing something of interest.

So far from my occupation becoming monotonous, I only regretted that my health did not allow me to remain at my post for the entire day, from before dawn until after dusk; the question of meals would have presented little difficulty. As it was, I was continually witnessing pretty incidents which would have delighted the heart of a photographer. One of the most eventful half-hours which I spent thus was when the young birds were only two days old. I had got to my place of concealment unobserved soon after noon, when a slight shower came on. The female at once appeared with food, of which she hastily disposed, and then settled down on her brood. Five minutes later the male arrived on the scene with a large supply of worms, cut up in lengths ready for distribution. It was charming to see the perfect understanding between the two parents; the mother, without otherwise moving, threw back her head and received a share of the worms; she then took her stand on the opposite side of the nest, and the pair dipping down fed the hungry mouths stretched up between them; finally the cleansing process was carried out as I have described, and the female resumed her seat. Very soon her mate was back, but this time having a smaller supply he refused point blank to allow her a portion. She reached up and tried to snatch it out of his bill, but he only held it higher, so there was nothing for it but to stand aside, and allow the proud father to do the work which he so evidently enjoyed. On his next return, however, five minutes later, he made amends by giving his partner a whole worm for her own consumption. About this time the shower of rain became a regular downpour, and the careful mother stood up, and shaking herself, spread out her wings until they overlapped the edges of the nest, thus completely sheltering her chicks beneath. Her back was dripping but she seemed well content; in fact it was as good as the bath that thrushes always delight in, and she passed the time preening her feathers with great care. Once or twice, in the most natural manner possible, she obtained a drink by catching a raindrop that trickled off a broad leaf beside her. Meanwhile the male was not idle, for when the shower suddenly stopped, he reappeared at once with a good supply of food, and his partner was enabled to fly off and stretch her limbs.

Later in the day I waited a whole hour and a half without once seeing the young fed, and had a practical illustration of the thrush's nervous temperament. The fact was that I had been ill-advised enough to put down within ten yards of the nest some crumbs, which both parents inspected from time to time with every sign of uneasiness. At the end of a long hour the male indeed summoned up courage to bring a specially large worm, but having got as far as the nest there he stood leaning over it, perfectly motionless, in a listening attitude for a good five minutes, and then, quite regardless of the four gaping mouths which he had been tantalising, he deliberately settled himself down on the brood. There he remained equally motionless for the next half-hour, at the end of which I left him with a long worm still dangling from his bill. I saw just the same thing happen on another occasion.

I should mention that about this time a pair of robins were intent on building inside the summer-house. When the young thrushes were nearly fledged one of the robins paid them a visit. They heard him coming, mounting up from branch to branch by the route their parents were wont to take. I saw them stretch their necks as usual in eager anticipation. It was comical to witness their dismay at the unexpected apparition; they subsided deep into the nest, while their visitor surveyed them with lordly disdain and then passed on.

The time was drawing near for the final departure of the brood. I was most anxious not to miss this, and was fortunate in actually seeing the first chick leave the nest. On the thirteenth day of their existence I was on the scene early in the morning, and saw at once that they were getting very restless and anxious to explore the wide world. Had I walked openly to the nest, there is little doubt that they would have flown off one and all without hesitation, as I had caused another brood to do a few days before. In this case, however, I had the much greater satisfaction of watching them screw up their courage to take the fateful step of their own accord. One youngster was disposed to take the lead from the first. In the absence of his parents he wriggled himself up till he so stood on the edge of the nest; after some hesitation he began to walk gingerly round it; he had almost got back into his place, however, when a parent appeared, and the latter found nothing amiss. Hardly had she flown off, when the adventurer was on his feet again, and stepped boldly off on to a branch. Finding all well so far, he fluttered down to a lower one, and there he stuck. Then, for the first time, I heard the familiar chirp of a young thrush, and I am inclined to believe that they never utter it until they are at large. His example was soon followed by two of the others, and this was the scene which met the eyes of their mother on her next visit. She seemed decidedly disturbed by the turn things had taken, and as an object lesson bestowed all the food she had brought on the exemplary chick that had stayed at home. A few minutes later he too had fluttered out. This led up to one of the most delightful tableaux of the whole series. All four young birds were now scattered, but still quite close, and holding on for dear life. The mother bird, as a last resort, took her stand at the nest with a tempting worm in her bill; there she waited, looking from one to another as if to invite them to return, and every now and then, by way of making her meaning plainer, she bent down into the nest and went through all the actions of feeding an imaginary brood. Several of her family appeared to think twice about going back, but knew not how to manage the return journey, till at last in disgust she ostentatiously swallowed the tit-bit herself. Presently, however, compelled to realize that a new phase of their home life had been entered upon, she bravely settled down with her constant mate to do all that was needful for their welfare, apparently recognising in her maternal wisdom the added perils that would beset her offspring in the next stage of their development.

* Knowledge, 1899, p. 133. † Knowledge, 1899, p. 178.

TWO FASHIONABLE FURS.

By R. Lydekker.

To those who are of an observant nature, an afternoon's stroll through any of the fashionable London thoroughfares during last winter must have revealed the prevalence of a fashion for the beautiful furs respectively known as blue fox and white fox. The skins of these animals are either worn entire as boas (or "necklets" as, I am told, they are called by ladies) or made up as muffs, and in either condition are strikingly beautiful. Blue fox has long been highly esteemed as a fur, skins selling for between ten and fourteen guineas a dozen years ago. White fox, on the other hand, has only during the last year or two been appreciated as its beauty deserves, the price per skin having risen from between half-a-crown and sixteen shillings and sixpence in 1891, to three or four guineas, or even more, during last season.

But it is not the price of either the blue or the white skins that I propose to discuss in detail in the present communication. The circumstance to which I desire to draw the attention of my readers is the very remarkable one that both the blue and the white skins belong to one and the same kind of animal. At first sight this may seem, perhaps, a fact of no special interest or importance. For, as we all know, certain species of mammals, such as the stoat or ermine, the mountain hare, and the lemming, are normally white in certain parts of their habitats in winter and dark-coloured in summer. Again, many mammals vary to a great extent in coloration according to locality, so that there may be dark-coloured and light-coloured races inhabiting different localities. The most striking instance of this is, perhaps, the bighorn wild sheep of North America, which in the Rocky Mountains is a "khaki"-coloured animal with a white rump, but in Alaska is nearly pure white all over throughout the year. It is true, indeed, that American naturalists prefer to regard the bighorns of the Rocky Mountains and Alaska as distinct species rather than local races of a single variable animal, but for our present purpose such slight differences of opinion do not really affect the case one way or the other.

That white fox and blue fox are not (as was once supposed to be the case by some naturalists) the summer and winter coats of the same individual animals, will be apparent by a comparison of furs of the two descriptions worn by our lady friends. The two descriptions have the same long thick hair, with a woolly under-fur at the base, and both are evidently the winter coats of the animals to which they respectively belong. Indeed, with all long-haired animals of the northern parts of the Old World, with the possible exception of the polar bear, it is the winter coat that is alone valued by the furrier.

That blue and white foxes are not local races of the same species (or distinct species) is evident from the fact that in certain districts both occur together, although in other localities (as in Iceland, where all the foxes are blue) only one form may be met with. It may indeed be possible that in some cases blue and white cubs may occur in the same litter. For instance, Professor A. S. Packard, in his work entitled "The Labrador Coast," states he was informed by a native "that the white and blue fox littered together, but that the blue variety was very rare." More precise information is required on the subject of their interbreeding, but it is quite certain that the blue fox and white fox of the furrier are only individual phases of the winter coat of a single species.

Although it is stated that white specimens are occasionally met with in summer, the white phase of the Arctic fox (as the species is called) normally assumes a dark coat in summer. The difference between the winter and summer coats of this phase of the species is well illustrated by a couple of specimens which have recently been placed in the central hall of the Natural History Museum, in Cromwell Road. In the case containing the mountain hare, ptarmigan, stoat, and weasel in their white winter dress has been introduced a specimen of the Arctic fox in the same coat. To contrast with this, the case in which are placed the above-mentioned animals in their dark summer costume now contains a specimen of the white phase of the Arctic fox in its dark summer livery. In this specimen, the hair (which is much shorter than that of the example in the winter dress) is dirty rufous brown shading into grey on the upper-parts and outer sides of the limbs, and yellowish white below. In other examples the colour of the upper-parts is greyer, while the under-parts are nearly pure white. Sometimes also, it is stated, that grey hairs are largely mingled with the white winter coat, so that we have a more or less marked tendency towards the blue phase even in the winter dress. In all cases the muzzle remains black, and it is stated that there may occasionally be a black tail-tip in the white winter dress. I have not seen a "blue fox" in the summer dress, but am told that the coat is then chiefly distinguished from its winter condition by its much shorter hairs and less pure blue colour.

Of course the so-called "blue" of even the best skins is a slaty or French grey rather than a blue in the proper sense of the word, and in many instances it tends to drab or dark purplish. Alaskan blue fox, which is somewhat coarse in the texture of the fur, has this purplish or sooty tinge most strongly developed, and at one time was specially valued on this account, although during the past season the lighter varieties seem to have been chiefly in demand.

Lest any of my readers should be led to think that the Arctic fox is a near relative of the common species, it may be well to state, before going any further, that it is a very distinct animal indeed. Apart from its coloration, the most distinctive features of the species are to be found in its short rounded ears (which look almost as though they had been cropped), moderately sharp muzzle, very long and bushy tail, and the coat of hair on the soles of the feet. From this latter feature the species takes its name of *Canis* (or *Vulpes*) *lagopus*; the object of the hairy soles being, of course, to afford the animal a firm foothold on the ice and frozen snow on which it passes so much of its time. In having two distinct colour-phases at all seasons of the year, which may be met with in the same locality, the Arctic fox stands practically unique among mammals. It is true that, according to Mr. F. C. Selous, black-maned and yellow-maned lions occasionally occur in the same litter, while black leopards and black jaguars are found now and then among litters of cubs of the ordinary colour. But neither of these instances are exactly on all fours with the case of the Arctic fox. With regard to the lion, it has now been ascertained that the black-maned and tawny-maned specimens belong, in most cases at any rate, to distinct local races; and, as Mr. Walter Rothschild has recently pointed out, it is most probable that when light and dark-maned cubs are met with in the same litter it is due to crossing between two of these races. Black or melanistic leopards and jaguars, on the other hand, are more analagous to albinoes, and generally occur in hot and damp climates. The black phase of the common water-vole, found high up in many British valleys, is an instance somewhat analogous to that of black leopards, being apparently due to climatic conditions, and therefore not strictly comparable with the case of the Arctic fox.

Many invertebrate animals exhibit two or more distinct phases,—generally differing to a certain extent from each other in details of form or structure—and to such the name of dimorphic species is technically applied. Naturalists have agreed to designate the Arctic fox by the same title, although, were it not that it might be taken to convey an altogether different meaning, the term dichroic would be more appropriate, seeing that the difference between the two phases is solely one of colour, and has nothing to do with shape or structure. Using, then, the term dimorphism as indicative of the existence in one animal of two distinct colour-phases totally unconnected with either locality or season, the Arctic fox appears to be the only mammal to which the designation can be properly applied.

The reason for this remarkable dimorphism in the Arctic fox is hard indeed to discover, and no satisfactory explanation of the puzzle appears hitherto to have been offered. It is almost unnecessary to say that the reason why Arctic and sub-Arctic animals turn white in winter is that they may be as inconspicuous as possible in their environment of snow and ice. And if blue foxes were met with only in countries where snow lies but a short time in winter, while white ones occurred solely in more northern lands, some clue to the puzzle might be forthcoming. But as a matter of fact this is not the case.

The distribution of the Arctic fox is circumpolar, extending in the New World about as far south as latitude 50°, that is to say, nearly to the southern extremity of Hudson Bay, and in the Old World to latitude 60°, or, approximately, to the latitude of Christiania and the Shetland Isles. Northwards the species extends at least as far as Grinnel-land.

In Iceland all the Arctic foxes appear to belong to the blue phase, and as that island is far to the south of many portions of the habitat of the species, it might be thought that this is the reason why the white phase is unrepresented there. But that island is far north of the line where the mountain hare and the stoat begin to assume a white winter livery; and if it is essential for these species that they should assimilate their colour to that of their surroundings, why is it not equally so in the case of the Arctic fox?

Again, although, as already mentioned, blue foxes are rare in Labrador, in Alaska they are comparatively common, and the same is the case in Greenland, whence, according to Mr. W. Poland, the Royal Greenland Company imported 1,451 to Copenhagen in 1891. And if it be essential for animals to turn white in winter in any country in the world, it is surely Alaska. It is difficult to ascertain the proportion of blue to white foxes in either Alaska or the Pribiloff Islands, but it is certain that in both localities the two phases are found together, living apparently under precisely the same physical conditions.

As regards the islands last named, Mr. Elliot, in his work on the "Seal Islands of Alaska," writes that—"Blue and white foxes are found on the Pribiloff Islands, and find among the countless chinks and crevices in the basaltic formation comfortable holes and caverns for their accommodation and retreat, feeding upon sick and pup seals, as well as water-fowl and eggs, during the summer and autumn, and living through the winter on dead seals left on the rookeries, and the carcases on the killing-grounds."

This account, then, fully establishes the fact that blue and white foxes occur in regions where, according to all accepted rules, there ought to be none but white individuals, during the long and dreary winter. It gives, however, no definite clue to the reason for the strange association.

There is, however, a description of the habits of Arctic foxes in Grinnel-land given by Colonel Fielden in his "Voyage to the Polar Sea," which may possibly throw some light on the subject, although unfortunately it does not tell us whether blue as well as white foxes are found in that region. After referring to the numbers of lemmings to be seen looking out from the mouths of their holes, or feeding in the vicinity, the author proceeds as follows:

"We noticed that numerous dead lemmings were scattered around. In every case they had been killed in the same manner; the sharp canine teeth of the foxes had penetrated their brain. Presently we came upon two ermines killed in the same manner. . . . Then, to our surprise, we discovered numerous deposits of dead lemmings; in one hidden nook under a rock we pulled out a heap of over fifty. We disturbed numerous 'caches' of twenty and thirty, and the earth was honey-combed with holes, each of which contained several bodies of these little animals, a small quantity of earth being placed over them. In one hole we found the greater part of a hare hidden away. The wings of young brent-geese were also lying about; and as these birds were at this time just hatching, it showed that they must be the results of successful forays of prior seasons, and that consequently the foxes occupy the same abodes from year to year. I had long wondered how the Arctic fox exists in winter."

Now it will be evident that in this instance the foxes killed the prey stored up for winter use while they were in the dark summer coat. And since in winter, when the birds have left and the lemmings have retired to the depths of their burrows, they have no game to capture and no enemies to fear save polar bears (which would not be likely to do them much harm), it would appear to be a matter of no consequence whether their coats be dark or light. Consequently, it seems a possible explanation of the phenomenon under consideration that the blue phase of the Arctic fox indicates a reversion to the ancestral coloration of the species, due to the fact that no advantage is to be gained by the assumption of a white livery. Such reversion might well take place only in certain individuals of a species, and would probably tend to become more or less completely hereditary. Before such an explanation can, however, be even tentatively accepted, it is necessary to ascertain whether the blue Arctic foxes of Iceland are in the habit of making winter stores of provisions. If they are not, but hunt their prey in winter, the theory will not hold good.

As regards animals which hunt their prey in winter, or are themselves hunted, it would seem essential that they should be white even in the highest latitudes, where the long polar night lasts half the year. For in the bright starlight—to say nothing of moonlight—they would, if dark-coloured, be almost as conspicuous on the snow as in daylight.

As regards the number of Arctic fox-skins which find their way into the market, Mr. Poland, writing ten years ago, states that from 25,000 to 60,000 of the white phase were then annually imported from Siberia, the greater number coming to Leipsic. The fur of these is of a rather coarse quality, quite different to that of the fine-haired Greenland skins. In 1891 about 9000 white skins were imported by the Hudson Bay and Alaska Companies, and nearly 1000 by the Royal Greenland Company. Of blue skins about 2000 were annually imported into London by the Alaska Company, and some 500 to Copenhagen by the Greenland Company, although in 1891 the number of skins sold by the latter body reached 1451. It is noteworthy that in the fur-trade Greenland blue fox skins are noted as being of the same fine-haired quality as the white skins from the same locality, while the Alaskan blue skins are equally coarse-haired, consequently there is presumptive evidence of the existence of a Greenland and an Alaskan local race of the species.

THE COMETS OF 1903.

By J. B. DALE, M.A.

IN the year 1903 the returns of eight periodical comets are due. It is very improbable, however, that more than two or three out of their number will be seen. Some of them will remain invisible on account of their unfavourable situation with respect to the earth at the time of passing their perihelia; and in the case of two at least, planetary perturbations will have disturbed the orbits to such a degree that the dates of their reappearances must be regarded as very uncertain.

The following list is based upon the elements obtained from the positions observed at last apparition :—

Comet.	Periodic Time in Years.	Approximate Dates of Last Aphelion Passage.	Approximate Dates of Next Perihelion Passage.	Number of times previously observed.
(1) Tempel-Swift	5·534	3 Mar., 1900	9 Dec., 1902	4
(2) Perrine ...	6·441	10 Feb., 1900	5 May, 1903	1
(3) Giacobini ...	6·549	3 Feb., 1900	15 May, 1903	1
(4) Spitaler ...	6·402	3 June, 1900	16 Aug., 1903	1
(5) Faye	7·566	1 Jan., 1900	13 Oct., 1903	8
(6) Winnecke ...	5·832	18 Feb., 1901	30 Dec., 1903	7
(7) Brooks ...	7·097	25 May, 1900	12 Dec., 1903	2
(8) D'Arrest ..	6·675	24 Sept., 1900	25 Jan., 1904	6

The first-named comet was discovered in 1869, and has been observed since at intervals of eleven years. During last aphelion passage it was in the neighbourhood of Jupiter, and in consequence of the attraction of this planet its return to perihelion will be somewhat later than stated in the table.

The comets bearing the names of Perrine and Giacobini were both discovered in 1896; Spitaler's was discovered six years earlier, and has already made one unobserved return. On the present occasion its distance from the earth will never be much less than twice the radius of the earth's orbit, so that very likely it will again escape detection. Apparent proximity to the sun will obscure Perrine's comet, but Giacobini's will be more favourably situated, and possibly may be seen after passing perihelion.

Three of the comets expected may be considered to be well-established members of the solar system. Faye's was discovered in 1843; in 1819 Pons discovered the comet that now bears the name of Winnecke, while D'Arrest's was discovered in 1851.

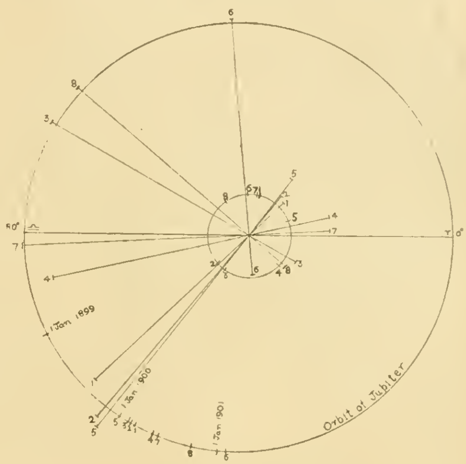
Unfortunately there is much cause for fear that the good character for regularity in its reappearances hitherto borne by Faye's comet will be found to have been lost since its last return. Its orbit lies close to that of Perrine's, and at the beginning of 1900 both comets were at their aphelia and near to Jupiter. Both bodies must have experienced considerable perturbations, but exact computations will alone show whether, in their new orbits, the comets will come within range of observation.

Neither Winnecke's nor D'Arrest's comets have suffered much perturbation, but, like Perrine's, they will at perihelion be on the opposite side of the sun to that on which the earth will be.

The remaining comet on the list, Brooks', is by no means so favourably situated as it was in 1889 and 1896; still its detection should not be regarded as hopeless. At the same time we must bear in mind that it has already shown signs of disintegration, and as yet we are so ignorant of all the conditions which determine the visibility of comets that it is presumption to speak with certainty regarding any of them.

All the above comets are members of a family closely connected with Jupiter. On the accompanying diagram are shown the major axes of the cometary orbits projected on the plane of the ecliptic, also the orbits of Jupiter and of the earth. The numbers placed at the extremities of the axes indicate the corresponding comets in the table, the numbered points on the orbit of Jupiter mark the positions of that planet at the aphelia of the comets, and the similarly numbered points on the earth's orbit its positions at the approaching perihelion passages.

It is noticeable that the aphelia points all lie close to the path of Jupiter. In addition to this, the inclinations of the planes of the cometary orbits to that of Jupiter are small, none exceeding 18°, while in every case the direction of revolution is the same as that of the general planetary motions. These facts indicate that whatever may have been the previous history of the comets, their present position in the system has been chiefly determined by the action of Jupiter, secondary of course to that of the sun.



This group of comets is of special importance in view of their comparatively short periodical times. They come frequently under observation, and every return adds to the material for writing their life-history.

In the triple system presented by any one of them in conjunction with Jupiter and the sun, we have one of the simplest cases of the problem of three bodies, a case upon which Hill, Poincaré, and Darwin have bestowed much labour, but whose complete solution is yet to be sought, if indeed it is attainable.

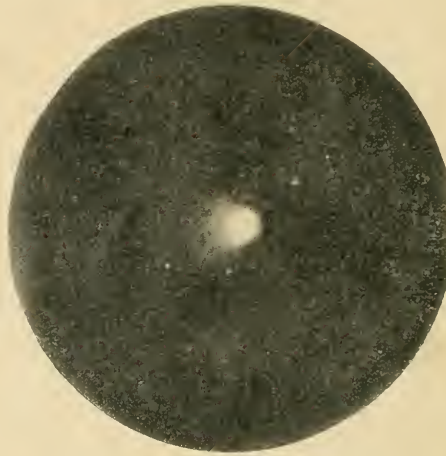
Perhaps the most striking circumstance which the study of these bodies has brought more prominently into notice, is that bodies moving under their mutual gravitation do not always tend towards aggregation and mutual coherence, but that disintegration is a frequent result. Jupiter not only captures comets, but also releases them, causing them to move in paths which may take them far beyond the limits of the solar system. Moreover, the condensation of a swarm of meteorites into a planet has yet to be explained, while it is not difficult to prove that the action of the sun, or of one of the larger planets, must under certain conditions bring about the disintegration of bodies passing near to them. Biela's comet is the classical example of such breaking up of cometary masses; but similar phenomena have been observed in comets Tempel-Swift and Brooks. For this reason their return may be looked forward to with interest.

"COMET PERRINE."

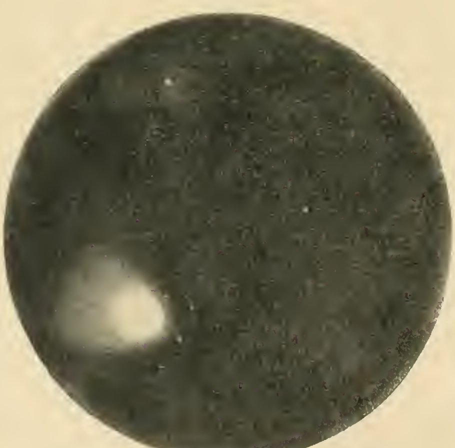
By MISS CATHARINE O. STEVENS.

MOONLIGHT has interfered very much with observations of the comet, but the exceptional series of cloudless nights during the latter part of September afforded opportunity for making the accompanying sketches, which are an attempt to convey some idea of its really exquisite beauty. The airy texture, the brilliance that is so delicately graduated from the glory of an arc light to a veil that scarcely dims the light of even a telescopic star, and that eludes even the skill of the photographer, furnishes an apology for the alternative of a portrait made by hand.

Comet Perrine.—11 p.m., 14 September, 1902.
[3 inch O.G., power 30.]



Comet Perrine.—9.30 p.m., 16 September, 1902.
[3 inch O.G., power 30.]



Comet Perrine.—8.37 p.m., 25 September, 1902.
[3 inch O.G., power 30.]

Comet Perrine.—Upon the background of the Milky Way.
12.5 p.m., 28 September, 1902.
[3 inch O.G., power 70.]

SOUTH.

NORTH.

THE SOUTHERN HORN OF THE CRESCENT MOON.

From a Photograph taken 1897, March 7th, 6·5h, Paris Mean Time, with the Great Equatorial Coudé of the Paris Observatory.
Scale: Diameter of Moon, 20¼ inches; Moon's Age, 4d. 6·4h.

THE MOON'S SOUTHERN HORN.

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

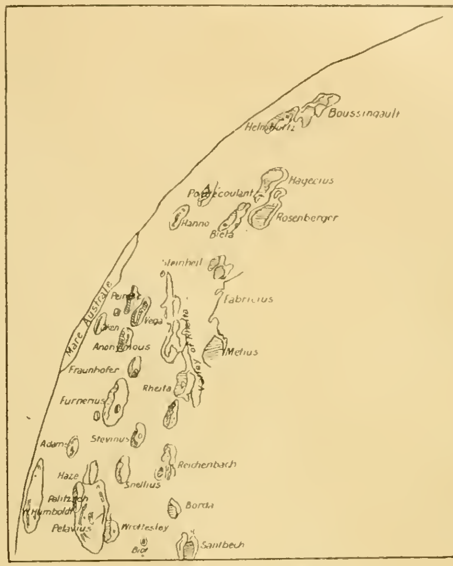
THE region of the moon shown in the present plate is taken from the fourth number of the "Atlas Photographique de la Lune," published by the Paris Observatory, and forms a continuation of the equatorial region of the moon described in KNOWLEDGE for March, 1901, under the title "Sunrise on the Sea of Plenty."

Under the grazing illumination of the sun's rays, it is seen that the moon's southern horn, like the major part of the moon's southern hemisphere, is riddled with craters. Here are a multitude of ringed and walled plains, craters and craterlets, clefts and ridges, lying, some in disorder, and some in an order so pronounced that it can scarcely be accidental. As it was pointed out in the earlier article, the meridian of 60° has upon it a series of great walled plains, Boussingault f, Pontécoulant G, Fraunhofer, Furnerius, Petavius, and beyond the southern horn the sequence is carried on by Vendelinus, Langrenus, Webb, Apollonius, Messala, and Schumacher, not to speak of the Mare Crisium, which the meridian bisects. This longitudinal arrangement of the great plains, taken in connection with the meridional ridges on the Mare Crisium, seems to indicate that the cause is to be found in the tidal attraction of the earth on the once plastic crust of the moon, which was then perhaps also exhibiting great volcanic activity.

Lying obliquely across the same meridian is another series of formations, scarcely less remarkable. These are four annuli composed of ring-plains and craters grouped together like beads on a necklace. The diameters of the annuli diminish in size, and their components also decrease as they approach the south pole. The largest and most northern annulus lies immediately to the south of Furnerius, and has for its southern edge the great Valley of Rheita and the ring-plains which it seems to have broken down in crossing. On its western border lie Fraunhofer and Vega and several other ring formations almost as large and important as these. The south edge is closed by several of the formations in the Vega region, but the northern edge lies open, save for the small crater Rheita B, between which and Fraunhofer lies a ridge of high ground which crosses the floor of the annulus, bending to the west and traversing Vega. The southern edge of this great annulus breaks into the northern edge of the next, whose southern apex is Hanno A, and, as a rule, the component ring-plains of the second annulus are much smaller than those of the first. The two more southerly annuli are formed of smaller craters still, and their areas are much more circumscribed. Pontécoulant joins the southern border of one to the northern border of the other, and obliterates them in these regions.

Three great valleys are seen stretching from the terminator across the illuminated horn, half way to the moon's limb, looking in the picture as if a hen had drawn her triple claw across the rugged surface. The two narrower shallower ones appear to spring from Fabricius, and skirt, one to the west of twin plains Steinheil A and B, and the other, farther to the west, to the borders of the second annulus. The third and most northerly, is the colossal Valley of Rheita, which, dwarfed by perspective, is yet nearly two hundred miles in length. It is less regular than the valley of the Alps, but it surpasses it visually in importance. In April, 1901, when discussing the ridges that cross the floors of the Maria Serenitatis and Imbrium, we pointed out that where these ridges left the sea bed and traversed the mountain ranges, there they seemed to be transformed into valleys; a notable instance being the prolongation of the great valley of the Alps into the Mare Frigoris, as a ridge to Egede A. In the case of the Rheita Valley and its companions, the only sea bed which is visible on this plate, the Mare Australe, is too narrow and foreshortened for it to be ascertained that the same coincidence of ridge and valley takes place here, but there are faint indications which seem to render it probable, and which might become more evident under a slightly different angle of illumination.

But as the sun rises higher on the moon's western limb, all this complexity of detail seems to be blotted out as by



Key Map of the Plate.

a wet sponge, and the region has become blank, or presents features that are unrecognisable when the sun's light slants on it as on March 7th, 1897. When the moon appears to us about half full, then Boussingault, Pontécoulant, Steinheil, and all the lesser ring-plains disappear; the Mare Australe shows up more plainly as a thin streak; the ring of Petavius is gone, and only the centre crater is to be made out; and the two secondary plains, Petavius B and Furnerius A, become the centres of brilliant "aureoles" and the focus of bright rays, such as those which emanate from Tycho.

But there is one feature which is no less evident when the moon is at the full than when it shows but a narrow horn of light; this is the especial brightness of the illuminated limb of the moon. On our plate it is visible as a narrow, almost even cornice of light all along the rounded edge. It is practically independent of the latitude on the moon, or of its age.

What is the cause of this? There is, of course, on the moon no atmosphere or dust-veil like that which renders the limb of the sun so notably less brilliant than the centre of the disk. But since the amount of light reflected by the moon in any given direction should decrease with increase of the angle made with the normal, we should expect that—as we see to be the case with Jupiter and Saturn—the limb should be inferior to the centre in brightness. There seems but one explanation of the different state of things which we observe, viz., that the regions near the limb, as we see them, have a much higher reflective capacity than those near the centre. Nor is it difficult to see that this is actually the case. In the centre of the disk we see spread out before us the great grey plains, the floors of the craters and ring-plains, the bottoms of the valleys. And we note that these low-lying regions are far darker than the mountain tops; in other words, the lowest regions are the darkest; the most elevated are the brightest. But as we approach the limb the effect of the foreshortened presentation is to hide the valleys and crater-floors more and more from view, whilst the mountain sides are more fully presented to us. The brightness of the lunar limb is therefore due to the fact that it is here that the highlands are best seen, and the lowlands least. On the planet Mars, which also shows a bright limb, the similar effect may be due to the presence of clouds, too thin to be seen when looked down upon from above—and probably also much rarer under the midday sun than at morning or evening—but becoming quite evident when crowded together near the limb by the effect of foreshortening. Just as to a spectator on the earth, the horizon seems much more frequently and more densely clouded than the zenith.

The interest attaching to the brightness of the lunar highlands depends upon the cause to which it is assigned. It is probable that the actual material of the grey plains and crater-floors is in itself darker than that of the mountain crests and ridges. But there must be an action continually going on—slight and slow, but cumulative—tending to *clean* the upper slopes, and to transfer material down to the lower districts; a kind of weathering. The meteor rain, which the moon experiences in its proportion equally with the earth, must tend to rake the surfaces of the steep ridges, and to drive the matter it disturbs downwards. So, too, the alternate expansion and contraction of free particles lying on the slopes, as the lunar day and night succeed each other, will mean the gradual "creeping" downwards. Thus, however "dead" the moon may be, there must be even now a steady kind of denudation at work, a continual deposit of material in the lowlands from the surface-matter of the mountain slopes.

The interesting point is that this deposited material seems darker than that uncovered by its removal, as if on the moon, as on the earth, some process of tarnishing or oxidation were at work; as if the lunar atmosphere, rare as it must be beyond all terrestrial experience, is not wholly inefficient in this direction.

Letters.

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

A NEBULOUS STAR IN SCUTUM SOBIESKI.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Prof. Barnard informs me that the star in Scutum Sobieski, S.D.—10°, 4713,* referred to in my article on "Nebulous Stars and their Spectra," in your October number, is undoubtedly and conspicuously nebulous. He has not only photographed the dense glow encircling it more than a dozen times with varied exposures, but observed it visually as well. Moreover, Prof. Frost has kindly examined a spectrograph of the star taken by Mr. Ellerman with the Yerkes refractor in the autumn of 1899, and finds it to be of the most authentic helium type. Besides hydrogen and helium absorption, Scheiner's "high-temperature" magnesium-line at λ 4481 was recorded between $H\beta$ and $H\gamma$. No bright lines could be detected. The object, accordingly, conforms to precedent, and ratifies the association of a helium spectrum with an inchoate condition. The experiment would be worth trying of taking a spectrograph on a plate sufficiently sensitive in the green to test the emission of the chief nebular ray by the halo attached to this interesting star.

Agnes M. Clerke.

London, October 23rd, 1902.

* Through an oversight, the erroneous designation B.D. 10° 4313 got printed in my article. The star's place for 1900 is R.A. 18h. 25·9m., Dec. —10° 52′.

THE CANALS OF MARS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—On seeing that Mr. Maunder had reached slightly different results with regard to the exact nature of the delusion to which these appearances were due, I was at first rather at a loss to account for the fact, since the subjects of my experiments had all seen the canals on perfectly unstippled surfaces. Lately, however, the idea occurred to me that perhaps Mr. Maunder had made his drawings more hard and definite in outline than I had, and I therefore wrote to Mr. Maunder suggesting this explanation, and shortly after received a letter from him stating that in his drawings he had shaded in the "seas" with Indian ink, and had used smooth white Bristol board on which to draw them, whereas I had drawn mine in black lead, on rough, slightly yellowish drawing paper. The difference in character between these two kinds of drawing seems to me to explain adequately the slight disparity in our conclusions.

It will be understood, of course, that if a drawing is stippled over with minute dots, which are individually indistinguishable, the net effect is not that of a speckled surface, but merely that of a general and even darkening of the space so stippled. This darkening has the same effect as the lightening of the dark areas would have, *i.e.*, it makes the drawing more difficult to see, and the eye having thus less to definitely lay hold of, has more free play, and is more easily deceived into representing shadowy lines.

The probability of the truth of this explanation becomes greater, of course, when it is considered that even my comparatively feeble drawings had to be placed in the shadow before canals could be easily seen.

Thus the inability of the subjects of Mr. Maunder's experiments to see canals on unstippled surfaces does not point, as might at first sight appear, to the hypothesis that the red areas of Mars are speckled over with oases, but merely to the fact that the light areas are not so much brighter than the dark areas as they were represented on Mr. Maunder's drawings, and to a smaller extent on my own.

As everyone knows, the markings on the planet itself are anything but strongly marked. Of course this darkening of the red areas may be caused by oases, but of this we have no proof, and it seems simplest to suppose, for the time being, that except for the large spots whose existence no one can doubt, there are on the Martian continents no markings visible to our present telescopes, and certainly no canals; at least in our present astronomical conception of the meaning of the term.

B. W. Lane.

VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In July last a letter from Dr. Ryle appeared in KNOWLEDGE, from which, and Mr. Maunder's note, it would appear that the seeing the crescent with the naked eye is almost, if not altogether impossible. Permit me therefore to relate the following:—In either October or November, 1901, I was viewing Venus, and looking for Mercury one evening. Finding the latter I called two of my men, who were working near by, to come and look at what they had probably never seen before. When I pointed the direction of Mercury, one of them at once made it out with the naked eye. I then showed it to him with the telescope—a 3-inch refractor. Venus at the time was very bright, and to test his sight I asked him "What shape she was"? His reply at once was "Just like the new moon," and added, to my astonishment, "Is that the rest of the star, the dark round we see"? I then let him look through the glass, and he said "Yes, just the same, only much clearer." I cannot say as to astigmatism of his eye, as I do not know anything about it; but I feel sure that there was no imagination at work. He did not even know the planet's name, and all he did, when I pointed Venus out, was to shade his eyes with his hand, and answer at once.

A. W. MANSERGH, Lt.-Col.

Martness House, Portadown,
1st November, 1902.

SYNCHRONISM OF SOLAR STORMS AND TERRESTRIAL MAGNETIC DISTURBANCES.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—From the report of the July meeting of the B. A. A., I gather that the above subject has been once again under discussion. The Rev. Walter Sidgreaves' essay on the "Connexion between Solar Spots and Earth-Magnetic Storms" (*R. A. S. Mem.*, Vol. LIV.) is about the only purely scientific pronunciamento which I have had the pleasure to read on this controversy. Both sides, however, to my thinking, commit the error of allowing their respective views to be too much influenced by basing them exclusively on the speculative relations between earth-magnetic storms and "*sun-spots*," as if these latter were the one and only solar storm phenomenon subject to periodic cycles. I liken a sun-spot to the black storm-cloud we see here on the earth, the cloud being, however, merely *the scenery* of the storm proper, in which lightning and thunder alternate, from which rain or hail may fall, and underneath which a tornado may do havoc. But if these real storm-ingredients are absent, the mere passage of a cloud across the same landscape would be of little consequence. Similarly, then, a solar spot taken as a dark mark on the sun's surface denotes simply an interruption in the luminous photospheric clouds. Such a spot is not necessarily the one absolute requirement to produce a terrestrial magnetic storm, and in this sense it would, indeed, seem advisable to drop the idea of an *absolute connexion* between the two phenomena.

There are quite a number of solar periodic phenomena, partly well known and partly justifiably surmised, which accompany the spot cycle, and these may be much more directly concerned in any action at a distance. To begin with, as far as solar spots go, every observer can see directly whether he has to do with an active or quiet spot. Again, he can see whether, on rounding the edge of the disc, the neighbourhood of a spot is studded with eruptive prominences or surrounded by brilliant faculæ, but both these he may see without a spot being visible near. But if no spot is visible, and these eruptive prominences and brilliant faculæ (indicative of a solar storm much more than the dark spots *per se*) are well within the sun's disc, their discovery is not so easy, and I feel sure that many tremendous outbursts are thus entirely lost to direct telescopic or spectroscopic observation. Even then we have no absolute evidence that distortion and reversals of lines, &c., constitute, with disturbed spots, the whole range of solar storm phenomena, and we are in entire ignorance as to what extent electric potentials of unsuspected magnitude may enter the arena of the upheaval. These electric contributions are so far entirely invisible to us, but the belief in their actual existence is none the less justified.

Therefore I do not see what purpose is served by debating as to whether one or another particular solar longitude of a sun-spot is the more productive of terrestrial magnetic storms. At the same time one might argue, theoretically at least, that the line of least resistance would be also the *shortest* connecting line between sun and earth, and that, therefore, *near* or *on* the central meridian a solar disturbance (not necessarily a spot) may have an enhanced effect.

In these debates on the relationship of solar phenomena and terrestrial magnetism, I notice that any attempt to account for the following circumstances is invariably left out of consideration:—

(1) How is the incontrovertible fact explained that terrestrial magnetic storms do not only synchronise with the spot cycle *in toto*, but accumulate in two annual maxima about the equinoxes?

(2) Why should a solar south latitude disturbance more frequently prove effective on the earth's magnetic condition in March (spring equinox) than a north latitude disturbance, and the reverse take place at the autumn equinox?

(3) How is it that terrestrial magnetic storms recur in subordinate periods, synchronous with the sun's sidereal rotation period, almost corresponding to the respective latitude of the solar disturbance; and why should this same subordinate synchronism be more strikingly apparent during the spring and autumn equinoxes?

Possibly a correct answer to question 1 would settle the second portion of question 3, but unless these three main questions can be satisfied, I feel bound to say that whatever be the immediate cause of the terrestrial magnetic disturbance, *this cause must be located on the sun* or in extremely close proximity to its photospheric surface; must partake of its rotation, differentiated according to latitude; must be more effective in spring and autumn through more favourable relative position of sun and earth; and, finally, must be synchronous with the spot period as a whole. Here then I part company with Mr. Sidgreaves, inasmuch as he says on page 91, *loc. cit.*:—

"It seems therefore true that recorded observations, while clearly asserting a real connexion between sun-spots and magnetic storms, *are against any theory which places the cause of magnetic disturbance within or near the sun.*"

Helmholtz's theory placed the cause of the sun's sustained heat radiation on that body itself. From the sun we also receive nearly all our light, and I do not see why we should show such hesitation to credit it also with sufficient electromotive force to influence the earth's magnetic condition. Could we but have an analyzing magnetoscope, after the analogy of the analyzing spectroscope, which would enable us *to watch magnetically any selected portion* of the sun's surface, we might come immeasurably nearer to a solution of this vexed question.

ALBERT ALFRED BUSS.

I think the solar storms [illegible] act on the earth [illegible]

P.S.—While no spots have been visible for some months now, the chromosphere seems to show a very rugged appearance lately, especially in the polar regions. A friend of mine has advised me to let the sun's light pass through a ruby-tinted glass when observing prominences, etc., in the H*a* (C) line, and I must say that it greatly assists me in obtaining good views, and I recommend the simple device to brother spectroscopists. A. A. B.

British Ornithological Notes.

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

Greenish Willow Warbler (Phylloscopus viridanus) in Scotland.—At the October meeting of the British Ornithologists' Club, Mr. Howard Saunders exhibited, on behalf of Mr. W. Eagle Clarke, a male specimen of this little Warbler. It struck the lantern of the Suleskerry lighthouse on September the 5th last. Suleskerry is a storm-swept rock about 35 miles from the nearest point of Sutherland. This specimen is the second example of the species obtained in Great Britain, the first having been shot by Mr. Caton Haigh in Lincolnshire, on September 5th, 1896. The Greenish Willow Warbler has been known to occur only some half-dozen times in Western Europe, although it breeds no further off than a little to the north-east of St. Petersburg. Its true summer home, however, is in the Urals and further east.

White-spotted Bluethroat in Kent.—The White-spotted Bluethroat is the southern form of the Red-spotted Bluethroat which inhabits arctic Europe and Asia, and often visits our southern and eastern coasts at the times of migration. The white-spotted form (*Cyanecula leucocyana*) had not been recorded for Great Britain until October last, when Mr. M. J. Nicoll exhibited a specimen of the bird to the British Ornithologists' Club. This specimen was picked up dead close to Dungeness lighthouse by a man named Gasson, on October 6th, 1902.

White-winged Lark (Alauda sibirica) in Kent.—Two examples of the White-winged Lark were obtained at Woodchurch, Kent, on January 27th and 28th, 1902, and at the time a third bird was seen. This was obtained on March 22nd. All three specimens have been exhibited by Mr. N. F. Ticehurst to the British Ornithologists' Club. Previous to these examples, the White-winged Lark had been obtained only once in the British Islands, namely, near Brighton, in November, 1869.

Rustic Bunting (Emberiza rustica) in Sussex.—The fourth example of this eastern species to be obtained in Great Britain was exhibited by Mr. N. F. Ticehurst at the October meeting of the British Ornithologists' Club. The bird was a young male, and was shot by a boy at North Croft Farm, Westfield, Sussex, on September 22nd, 1902.

Little Bunting (Emberiza pusilla) at Tees Mouth, Co. Durham (*Naturalist*, November, p. 353).—Mr. C. E. Milburn records the occurrence of a bird of this species on October 11th, on the Durham side of the Tees mouth. The specimen, which is a female, was exhibited by Mr. W. R. O. Grant at the October meeting of the British Ornithologists' Club. The Little Bunting breeds in Northern Russia, and has only once before been recorded as occurring in Great Britain.

Aquatic Warblers (Acrocephalus aquaticus) in Sussex.—At the October meeting of the British Ornithologists' Club, Mr. Bonhote exhibited a pair of Aquatic Warblers, shot at Winchelsea, Sussex, last August. The bird, which breeds in France and Germany, has been previously noticed some half-dozen times in England.

Lesser Grey Shrike (Lanius minor) in Norfolk.—At the October meeting of the British Ornithologists' Club, Mr. G. E. Lodge exhibited a young specimen of *Lanius minor*, which he had shot on October 11th, at Docking, in Norfolk. The Lesser Grey Shrike, which is an annual summer-visitor to Southern and Central Europe, occasionally wanders to England at the migrating seasons.

Glossy Ibis in Hampshire and Sussex.—Mr. Edward Buckell writes that a Glossy Ibis was shot near Romsey, Hants, on October 19th last; while Mr. F. Ashburnham records (*Field*, November 8th, 1902, p. 808) that a specimen was shot near Rye at the beginning of October, and another in Pevensey Marsh, in Sussex, in the middle of October.

Red-necked Phalarope in Anglesea.—In the course of an interesting article on the birds of Anglesea, Messrs. T. A. Coward and Charles Oldham describe how they watched a bird of this species, on June 5th and 6th, on a shallow pool. Although it still breeds in the islands in the north of Scotland, the Red-necked Phalarope strangely enough is seldom recorded from England, and less often from Wales, in spring, although those countries lie between the birds' winter and summer quarters. The authors of this paper draw attention to a conspicuous white spot above the eye of the bird, which was distinctly noticeable in the live bird, but, they say, is practically obliterated in dried specimens, owing to the contraction of the skin over the orbit.

Great Bustard near Cambridge.—A Great Bustard was shot near Cambridge, on September 25th last. This was presumably one of the birds which were put down in Norfolk in 1900 in the hopes that the species would re-establish itself in its former haunts (*see* Knowledge, 1900, October, p. 230). Several of these birds, unfortunately, have now been shot by ignorant people. In the present case, the farmer who shot the bird, when convicted of the offence, expressed his regret, explaining that he did not know what the bird was, and had not seen any of the notices which had been published in the neighbourhood in order to draw attention to the presence of the bird, and to ask for its protection. If those directly interested in the reintroduction of this fine bird will persist in their efforts by importing a few pairs of birds each year, and advertising their presence, there is every reason to hope that the experiment will prove a success. In a few years' time, perhaps, it will not be necessary for us to go all the way to Spain to see the finest bird on our game list.

Alpine Swift in Kent (*Field*, November 1st, 1902, p. 761).—Mr. H. S. D. Byron states that an Alpine Swift was shot at Thanet on October 21st, but he gives no particulars of the bird.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at the Office of* Knowledge, 326, *High Holborn, London.*

NOTES

Astronomical.—The repetition of Foucault's pendulum experiment at the Pantheon in Paris has attracted considerable attention, though it is only remarkable for the large scale on which the experiment is performed. It may not be generally known that there is a permanent exhibition of the experiment in the Science Collections of the Victoria and Albert Museum at South Kensington, where the demonstration of the earth's rotation is completely satisfactory, in spite of the fact that the pendulum wire is only 40 feet in length, as compared with the 220 feet of the Pantheon experiment. Excellent results have also been obtained by the writer of these notes with a carefully suspended pendulum not more than seven feet in length, the deviations being often correctly shown for three-quarters of an hour.

Following up a general solution of an equation due to Laplace, Mr. E. T. Whittaker, one of the secretaries of the Royal Astronomical Society, has been led to the important conclusion that gravitation is in all probability propagated by undulations in the same medium by which light is transmitted through space. This undulatory theory requires that gravity should be propagated with a finite velocity, but this velocity need not be the same as that of light, and may be enormously greater. Mr. Whittaker is careful to point out that his investigation does not explain the *cause* of gravity, but shows that the propagation across space of forces which vary inversely as the square of the distance does not require for its explanation any new property of the transmitting medium. The development of the theory will be awaited with the greatest interest.—A. F.

BOTANICAL.—The "Origin of the Deadnettles in Britain" is discussed by Mr. S. T. Dunn in a paper which originally appeared in the *South-Eastern Naturalist* for 1901. He divides the species found in the British flora into three groups. The first includes *Lamium galeobdolon* alone, as this is the only British species found naturally in our woods; the second group includes *L. album*, *L. purpureum*, *L. incisum*, *L. amplexicaule*, and *L. intermedium*, all of which are unknown in Britain except in places prepared unintentionally for them by man; and the third consists of *L. bifidum*, seeds of which were introduced with foreign corn, and *L. maculatum*, which originated as an escape from gardens. *L. galeobdolon* is distributed through Western Siberia and Europe (including southern and central England), but is unknown in the most northerly regions. It is supposed that it spread into this country from the continent at the end of the last glacial period, before man had made his appearance in North-western Europe; it is, therefore, regarded as truly indigenous in Britain. Mr. Dunn shows that the extremely common White Deadnettle (*L. album*), and the other species associated with it in the second group, were introduced by the agency of man. The White Deadnettle is widely spread in the North Temperate Zone, both as a native and as a weed. It naturally grows in woods and forests, but in the British Islands it is not known in these habitats, though common enough wherever the ground is subjected to periodical disturbance. The Purple Deadnettles (*L. purpureum* and *L. incisum*) are weeds in Britain, and are commonly found as such throughout Europe, North Africa, the Orient, and Siberia. *L. amplexicaule* is unknown except as a weed of cultivated ground, and Mr. Dunn suggests that it has been derived from *L. macrodon*, a native of the cedar forests of Asia Minor, which, on extending its range into cultivated ground, became somewhat modified by its altered surroundings. *L. maculatum*, though clearly non-indigenous in Britain, is wild in the woods of Southern Belgium. This interesting paper has been reprinted in the October number of the *Journal of Botany*.

Two British local floras have recently been published, one dealing with the Liverpool district and the other with the East Riding of Yorkshire. The first, edited by Dr. C. T. Green, includes the plants growing within fifteen miles of the Liverpool Town Hall and two miles of Southport. It is based on the "Flora of Liverpool," issued by the Liverpool Naturalists' Field Club in 1872; but the present work contains several new features. A most useful one is the addition of pretty little figures of most of the plants. Further, there are twenty-one photographs of the scenery of the district. The flowering plants, ferns, fern allies and Characeæ included in the flora amount to 1060 species. The "Flora of the East Riding of Yorkshire," by J. F. Robinson, contains 1035 species, including 137 aliens, casuals, etc., and 20 "incognita." Mention should also be made here of Mr. F. H. Davey's "Tentative List of the Flowering Plants, Ferns, etc., known to occur in the County of Cornwall," which was issued a few months ago. —S. A. S.

ZOOLOGICAL.—The opinion seems to be gaining ground among zoologists that there are two distinct forms of okapi. In the October issue of the *Proceedings* of the Zoological Society, Dr. Forsyth Major applied the name *Ocapia liebrechtsi* to the form represented by a male skull from the Congo Free State, recently received in Brussels. On the other hand, Prof. Ray Lankester (*Ann. Mag. Nat. Hist.* for November) believes this form to be the true *O. johnstoni*, as typified by the strips of skin described by Dr. Sclater as *Equus* (?) *johnstoni*. Accordingly he proposes the name of *O. erikssoni* for the form represented by the mounted specimen in the British Museum, hitherto assigned to the typical species. Dr. Major has further stated that the female *O. johnstoni* (= *liebrechtsi*) is hornless; and the same will probably hold good for the other form. Assuming this to be the case, and also admitting the existence of two distinguishable forms, it has yet to be proved that these are anything more than local races of a single species.

In a paper recently published in the *Proceedings* of the Royal Physical Society of Edinburgh, Mr. O. C. Bradley proposes a system of skull-measurements for mammals, analogous to the "craniometry" employed in the case of the human subject.

Certain very remarkable prehistoric sketches of animals from the cave of Font-de-Gaume, in the Dordogne, are reproduced and described by Messrs. Capitan and Breuil in a recent issue of the *Comptes Rendus* of the Paris Academy. The animals depicted are the reindeer and the Pleistocene bison. Consequently, if genuine, the drawings must apparently be assigned to the Palæolithic epoch.

Much interest attaches to the description by Dr. C. W. Andrews (*Geological Magazine* for October) of a series of vertebrate remains—chiefly mammalian—from a Pliocene deposit on the Wadi-Natrun, Egypt. The remains include those of a three-toed horse (*Hipparion*), of a hippopotamus identified with a species previously described from a formation of the same age in Algeria, of an antelope apparently inseparable from the *Hippotragus cordieri* of the South of France, and of an undetermined species of pig. This new fauna apparently confirms previous conclusions as to a land-union between Europe and North Africa in Pliocene times.

Those who would explain the distribution of certain forms of life by the former existence of a land-connection between the southern continents by way of "Antarctica," have laid some importance on the existence of fishes of the genus *Galaxias* in the freshwaters of New Zealand, Australia, South America and the Cape. This evidence, for what it is worth, has been completely shattered by Mr. G. A. Boulenger's description (in a memoir on the fishes of the Congo) of a marine representative of the genus in question from the Southern Ocean.

In a memoir recently published at St. Petersburg, Dr. Otto Herz describes the journey of the expedition under his charge to the Beresowka River, in North-eastern Siberia, to exhumate and bring home the remains of a frozen mammoth. Although the carcass had lost the trunk and one of the tusks before the arrival of the party, the expedition was a complete success, having reached the Beresowka and completed its task before the setting in of the winter frosts. Leaving the Beresowka in November, the party reached St. Petersburg in February last, where they made over their spoils to the Academy of Sciences.

Another memoir lately published at St. Petersburg is devoted to a full description of the wild horse of Mongolia, based on the rich series of specimens in the museum and on examples living at Moscow. The author, Dr. Salensky, is convinced that *Equus przewalskii* is a distinct animal and not a hybrid, but does not decide whether it is a separate species or merely a local or feral race. In the course of his description the author mentions the interesting fact that the callosities generally present on the hind legs are wanting in some individuals of the domesticated horse and the wild tarpan. Commenting on the memoir in the *Field* newspaper, Mr. Lydekker expresses the opinion that the Mongolian wild horse can no longer be regarded as anything more than a race, or sub-species, of *Equus caballus*.

In the journal last mentioned (October 4th and 11th) the same writer discusses the coloration of the larger mammals, and concludes that in most instances this is designed for the purpose of protection, by harmonizing with the inanimate surroundings. It is pointed out that forest-dwelling animals may nearly always be distinguished by the large size of their ears, as compared with those of their nearest relatives. The need of accurate observations in the field with regard to the meaning and use of animal coloration is urged, and the assistance of sportsmen and travellers in clearing up matters of doubt invited.

In a note on the Pleistocene fauna of Nebraska, published in Vol. XVI. of the *Bulletin* of the American Museum, Mr. W. D. Matthew describes, under the name of *Capromeryx*, a new type of ruminant, which is regarded as the direct ancestor of the American prongbuck (*Antilocapra*). The author considers that both animals are descended from a group of ruminants termed "antilopine deer"; that group being characterised by the possession of antlers approximating to those of the deer, coupled with teeth more like those of antelopes. The antlers, which are forked or several times branched, are provided usually, or invariably, with a "burr," whence it would appear that they were annually shed. On the other hand, they are smooth, which suggests that they were permanently invested with "velvet." In another communication to the same journal Mr. Matthew describes the skull of a rodent from the Tertiary of Colorado provided with three horns. For the animal to which it belongs he proposes the name *Ceratogaulus*. A horned rodent is a type quite new to science.

Number 466 of the *Proceedings* of the Royal Society contains an abstract of Dr. W. G. Ridewood's important memoir on the structure of the gills of the bivalve molluscs. No less than 215 species, referable to 118 genera, were examined in order to determine the structure of the gills. Speaking generally, neither the minute structure nor the mode of arrangement of these organs is of much value in classification; although three main types of gill-structure, apparently representing as many grades of complexity, can be recognised. The first and simplest of these types is met with only in the families *Nuculidæ* and *Solenomyidæ*, which have consequently been brigaded together under the name of Protobranchia.

The Gordon Memorial College at Khartoum, which Lord Kitchener opened on November 8th, is now ready for the Chemical and Bacteriological Research Laboratories presented by Mr. Henry S. Wellcome during his recent visit to the Soudan. The fixtures and appliances made in England have already been shipped. The equipment for scientific work is most complete and should be equal to any similar laboratories in Europe. The Sirdar has appointed as Director of these Research Laboratories, Dr. Andrew Balfour, of Edinburgh. The Soudan presents exceptional opportunities for the study of tropical diseases, especially malaria, typhoid and dysentery, and the results of the investigations of Dr. Balfour and his staff should be of considerable importance. Dr. Balfour will also assist the authorities in the investigation of the criminal poisoning cases which are frequent in the Soudan. The character of the poisons used by the natives is at present often obscure, and it is possible that the work in these laboratories may increase our knowledge of toxic agents. Apart from the original researches and general sanitary work, Dr. Balfour and his staff will devote their attention to the study of the cereals, textile fibres, and various matters affecting the development of the agricultural and mineral resources of the country.

Notices of Books.

"Astronomy without a Telescope." By E. Walter Maunder, F.R.A.S. (Knowledge Office.) Illustrated. Pp. xii. and 280. 5s.—There are many classes of readers to whom, we believe, Mr. Maunder's new book will appeal strongly. Those who wish to gain a close personal acquaintance with the stars will find themselves provided with an excellent set of star maps, and conducted by one who has a thorough knowledge of the heavens; those interested in the names of stars and constellations will find an admirable account of their origin and significance, as far as they can be traced; and the many who will doubtless wish to turn their knowledge of the stars to good account will find numerous valuable suggestions as to fields of research in which the unaided eye is not only competent to yield results of value to science but is often the only suitable means of observation. "Astronomers without telescopes" may be roughly divided into two classes, which may be briefly described as "fireside astronomers" and "open-air astronomers." Many useful investigations have been made by some of the former, and may still be undertaken by them with advantage; but it is to assist those desiring to make observations for themselves that the author's efforts are chiefly directed. Even if the observations are restricted to phenomena which are already perfectly well known and understood, the observer will in this way acquire a knowledge which no amount of reading could ever supply; but with Mr. Maunder's guidance he will find it possible to go further and take a share in various astronomical inquiries. Following chapters on the constellations, full and thoroughly practical directions are given for astronomical exercises intended primarily for the "education" of the reader, and these are appropriately followed by suggestions as to the systematic observation of meteors, the Zodiacal Light, Auroræ, the Milky Way, and other phenomena for which no telescope is necessary. That there are so many investigations open to the astronomer without a telescope is perhaps one of the most important lessons which the book brings home to us, and, as the author points out, there is a real danger that such observations may be neglected in view of the widespread attention attracted to the work of the great instruments which have been set up in recent years. Readers of Knowledge will recognise in the book much which has already appeared in our pages, but it may be mentioned that the original articles have to a large extent been rewritten and new illustrations included. We think that many of those who are thus already familiar with the general scope of the work will be glad to have the papers in a collected form, and it is confidently believed that the book will attract a wide circle of readers, and materially contribute to the advancement of several branches of astronomy.

"Birds in the Garden: Studies with a Camera." By Granville Sharp, M.A. (Dent.) Illustrated. 7s. 6d. net.—Mr. Sharp has written a very pleasing and entertaining little book on a few birds to be found in almost any garden. With the use of very simple photographic apparatus, and a few contrivances for bringing the birds within range of the camera, he has managed to secure an excellent series of pictures of the birds about which he writes. These photographs show very well how varied are the attitudes of birds and how expressive those attitudes often are. Photographs of this description are so much more interesting and valuable than those of birds and animals in ordinary "quiet" attitudes. Take, for instance, Fig. 33, where some young Great Tits are shown sunning themselves. The author says, "They went about it quite deliberately, flying over to a part of the garden that they otherwise neglected, just where a slope in the ground caught the full blaze of the sun. Here they would spread themselves out two or three at a time, settling their feathers edgewise to the sun, so as to take in all the heat they could." For the photographs themselves we have nothing but praise, but Mr. Sharp has been most unfortunate in the way the block maker has treated the results of his skill and patience. The backgrounds have in most cases been cut away, presumably by the mechanical "process engraver." In this work no discrimination has been made in many cases between parts of the birds and parts of the background, and as a consequence, in some of the illustrations portions of the background have been left as though they belonged to the birds, while, in others, parts of the birds have been cut away in mistake for the background. In this way, many of the photographs have been spoilt, and we need only instance the figures opposite to page 46, where the legs, beaks, and tails of the birds have greatly suffered by this merciless pruning. We hope that a favourable reception of his book will induce Mr. Sharp to give us further "chats" about the birds of his garden, and that no mechanical engraver will be allowed in future to "improve" the photographs.

"Experiments in Aero-dynamics." By S. P. Langley. (Published by Smithsonian Institution.)—This classical work reappears in a fresh edition, with but little addition to the subject matter as published in 1891. The central fact, on which depends the importance of the long and exhaustive experiments dealt with, is practically a refutation of the statement found in elementary text-books, that if a ball be shot from a cannon horizontally at any given height above the ground, and if a second ball be dropped vertically at the same instant as the discharge, the two projectiles will reach the ground at the same time. Substituting for the cannon ball a thin material plane projected horizontally in its own plane, Prof. Langley shows that the body behaves almost as though deprived of weight, supplying thereby a phenomenon possibly analogous to that of the rapid skater travelling in safety over thin ice. The general conclusion to which the master experimentalist is led is that we already possess in steam engines as now constructed, or in other heat engines, more than the requisite power to urge a system of rigid planes through the air at a great velocity, making them not only self-sustaining but capable of carrying other than their own weight. The volume must remain one of the most unique and valuable of the Smithsonian contributions to knowledge.

"Aerial Navigation." By Frederick Walker. (Crosby Lockwood & Son.)—The author of this unpretending little volume, "the aim of which," we are informed, "is to convey elementary instruction in a popular manner," has succeeded in packing a certain amount of useful and practical matter within its hundred and fifty pages. The opening chapter introduces us to a comparison of the capabilities of winged creatures, from the albatross to the flying fish, and is of a readable nature. The succeeding chapters, however, dealing with Aerostatics and Aerodynamics, are, unfortunately, difficult to follow, giving the idea of having been compiled in too great haste. In addition to mere slips of the pen, there are loosely-worded sentences which are ungrammatical or obscure, and instances where formulæ are faulty and statements or reasoning inaccurate. As examples we may point to the following:—"Altitude in feet (A) may be computed from the log. of barometer reading in inches (b) from the formula $4771 - b \times 6{\cdot}000 \times t = \mathrm{A}$, where 4771 is 30 log.," and to a very remarkable sentence or two on page 16. A chapter dealing with air-ships is copiously illustrated and well compiled for the purposes of a technical manual. Whether the little volume will be found to be really what it professes to be —"a practical handbook on the construction of dirigible balloons, aerostats, &c."—may perhaps be doubted, but it is not without information valuable to the mechanic, and contains useful tables which will be handy for reference.

"The Primrose and Darwinism." By A Field Naturalist, M.A.(Camb.). xiv. + 233 pp. (Grant Richards.)—It will be admitted that an author sets before himself no easy task when he tries to show that Darwin's famous observations on the cross-fertilisation of flowers were for the most part faulty, and that the accepted theories, based on these observations, are unscientific and absurd. Such, however, is the object of the present book. The author repeatedly criticises Darwin's use of the net to exclude insects from the flowers under observation; yet he does not, we believe, bring forward any experimental evidence that the net really has the sterilising influence he attributes to it. He is surely acquainted with the method of blank experiment! Similarly, commenting upon Fritz Müller's observations upon orchids, he says the flowers were, "in all probability, under protection in a greenhouse," and then proceeds to criticise the "probable" conditions of the experiments. Further, in face of Darwin's explicit statement that "the cowslip is habitually visited during the day by the larger humble-bees, and at night by moths," the critic includes the cowslip in a list of "a dozen of our brightest and most conspicuous common flowers which are rarely, and in some cases never, visited by bees at all." It is interesting, therefore, to find the anonymous author declaring that "for Darwin to set up as a judge in Nature's divorce court . . . transgresses a little, we think, the bounds of modesty." In spite of the flaws we have indicated, we believe Darwin would have been the first to welcome this volume. It at least makes clear the necessity for further investigation of the subject. The twenty-three illustrations are admirable.

"Astronomy with an Opera-glass. A Popular Introduction to the Study of the Starry Heavens with the Simplest of Optical Instruments." By Garrett P. Serviss. Eighth Edition. (Hirschfeld Brothers.)—This is a re-issue of the eighth edition, published by D. Appleton and Co. in 1896. Instead of the dark-blue cover of the earlier book, where fair Andromeda hangs chained in a starry sky, and a pair of opera-glasses occupies the right-hand corner of the foreground, the volume is now clothed in green with a picture of Saturn and his Rings, in exact conformity with "The Pleasures of a Telescope," and "Other Worlds," by the same author. This cover is not so appropriate to this book as to the others, since Saturn offers no opportunities to the astronomer with an opera-glass, save that of tracing his slow motions through the stars. Those who have read anything from Mr. Serviss' pen will not need any recommendation of the present volume. His close acquaintance with, and enthusiasm for his subject, his fresh and easy style, render all his writings attractive, and he is especially at home in the subject of this present volume. He has not confined himself in it to a mere description of the objects as they may be seen with a binocular, but has supplemented it by what has been learned concerning them by means of more powerful instruments, and by the histories, folk-lore, and traditions that have come down to us concerning them. Perhaps the most interesting account in a book where there is nothing dull is that of the Pleiades. He relates the traditional or proved changes in the brightness of the various stars and of the nebula; of Merope, who married a mortal and whose star therefore became dim amongst her sisters; of Electra, whose tears at the burning of Troy blotted out her star; of Asterope, the reputed spouse of Mars. Electra is now the brightest star of the group save Alcyone; Asterope is only visible in the glass; whilst Merope now shines plainly to be seen with the naked eye. And from this Mr. Serviss deduces the quite unastronomical moral that, "notwithstanding an occasional temporary eclipse, it is, in the long run, better to marry a plain mortal than a god." In this new issue it is to be regretted that no notice is taken of the changes of the new star in Perseus, nor of the great naked-eye comet of 1901, both of which offered good fields for observation with the opera-glass.

"Index to the Literature of the Spectroscope 1887-1900, both inclusive)." By Alfred Tuckerman. 1902.—This is one of the Smithsonian Miscellaneous Collections, and is a continuation of the previous Index by the same author published in 1888. It consists of two parts—Author-Index and Subject-Index. The preparation and publication of these bibliographies places the student under a very heavy debt to Mr. Tuckerman. There seems, however, one criticism to be made on the manner in which Mr. Tuckerman has carried out his task—viz., that the papers catalogued are by no means confined to spectroscopy, but embrace a considerable number relating to general astronomy, selected without any obvious purpose, and, in many cases, not even remotely connected with the title of the bibliography. This is a pity, as, on the one hand, it unduly swells the book, and may often cause the student to refer to papers that have no reference to his special line of research, whilst, on the other hand, it entirely fails to fill the larger programme of a bibliography of astronomy as a whole.

"Manual of Astronomy." By Prof. C. A. Young, Ph.D., LL.D. (Ginn & Co.)—Prof. Young has already issued two text-books in astronomy, "The Elements of Astronomy," and "General Astronomy," both of which are models of their kind. The present book is for the use of those who find the first not sufficiently extended for their purpose, but for whom the second is too large for convenience. A most excellent text-book it is, clear, full and yet not redundant, from the "Preliminary Considerations and Definitions," which constitute Chapter I., to the Appendix, giving instructions for the calculations of eclipses, and many tables of the elements of the solar system, of comets, of the motions and parallaxes of stars, and of variable and double stars. The index itself is not such as other indexes are, but following the name of each astronomer is the date of his birth if known, and if unknown, a note of interrogation. The date of death is also given, if this has taken place, and if otherwise a long dash acts as a sort of *memento mori*. The text-book is one that will prove of eminent practical value to the working astronomer. We would, therefore, like to see incorporated in its next edition yet more tables and formulæ, such as the astronomer is always needing, and for which he can very rarely trust his unaided memory. The formulæ for the solution of spherical triangles would prove most useful, and it might not be impossible to devote a few pages to a set of four-figure logarithms, an addition which would make the book a most complete one. Prof. Young gives an interesting and serious explanation of the fact that when high in the sky "the moon appears about a foot in diameter." He attributes it to "the physiological fact that our muscular sense enables us to judge moderate distances pretty fairly up to 80 or 100 feet, through the "binocular parallax" or convergence of the eyes upon the object looked at. Beyond that distance the convergence is too slight to be perceived. "It would seem that we instinctively estimate the moon's distance as small as our sense will permit when there are no intervening objects which compel our judgment to put her further off." There are one or two minor errors. Thus on p. 41, the 3-ft. reflector presented to the Lick Observatory by Mr. Crossley was made by Mr. Calver, not by Mr. Common, as Prof. Young says. Mr. Common bought it from Mr. Calver and sold it to Mr. Crossley. And on p. 54, the almucantar is used in England in the University Observatory of Durham, not of Cambridge.

"EXPLANATIONS OF TERMS AND PHRASES IN ENGLISH HISTORY." By W. T. S. Hewett. (Elliot Stock.) This is a very useful companion to the general reader in English history, and the plan of the book is capable of considerable extension. Some of the definitions are loose and inadequate, but we hope the compiler may be encouraged to return to the subject, when we would suggest the insertion of authoritative definitions wherever that is possible.

THE *Irish Naturalist* for November is devoted to a special report of the British Association meeting at Belfast. A general account of the meeting, and of the papers read and excursions made, is given, but the valuable part of the report consists of the abstracts of papers dealing specially with Irish natural history, read in the sections devoted to geology, zoology, geography, and botany. Irish naturalists, and all interested in the natural history of Ireland, should procure a copy of this issue of our contemporary.

MESSRS. F. E. BECKER & CO., of Hatton Wall, have sent us an elaborate catalogue of balances, scales and weights, containing more than one hundred pages of illustrated descriptions of all kinds of balances and weights used in scientific work. The educational value of practice in the exact use of accurate balances is great, and the introduction of this work into the schools may be induced by the production of such instruments for the use of students at reasonable prices. We would recommend all those who are interested to obtain a copy of this catalogue.

WE have received from Messrs. Isenthal & Co. a copy of the Catalogue of Max Kohl, of Chemnitz, for whom they are sole agents in the United Kingdom and its Colonies. This remarkable catalogue covers probably all instruments required in the various branches of physics, as well as apparatus for chemistry.

BOOKS RECEIVED.

Structure of the Universe (The Rede Lecture, June 10th, 1902). By Osborne Reynolds, M.A., F.R.S. (Clay.) Illustrated. 1s. 6d. net.

School of the Woods. By William J. Long. Illustrated by Charles Copeland. (Ginn & Co.) 7s. 6d.

Text-Book of Physics. By J. H. Poynting, SC.D., F.R.S., and J. J. Thomson, M.A., F.R.S. (Chas. Griffin & Co.) Illustrated. 10s. 6d.

Agricultural Industry and Education in Hungary. Compiled by T. S. Dymond. (Chelmsford: County Technical Laboratories). Illustrated. 2s. 6d. net.

Elementary Photo-Micrography. By Walter Bagshaw. (Iliffe.) Illustrated 1s. net.

A Naturalist in Indian Seas. By A. Alcock, M.B., LL.D., F.R.S. (Murray.) Illustrated. 18s. net.

Dominion of the Air. By the Rev. J. M. Bacon. (Cassell.) Illustrated. 6s.

Advanced Hygiene. (The Organized Science Series.) By Alfred E. Ikin, B.SC (HONS.) LOND., L.C.P., and Robert A. Lyster, M.B., B.CH., B.SC.LOND. (University Tutorial Press, Ld.) Illustrated. 3s. 6d.

"*Eyes Within.*" By Walter Earle, M.A. (Allen.) 5s. net.

Practical Landscape Photography. By G. T. Harris, F.R.P.S. (Iliffe.) 1s. net.

Religion as a Credible Doctrine. By W. H. Mallock. (Chapman & Hall.) 12s.

Modern Spiritualism. By Frank Podmore. (Methuen.) Vols. I. and II. 21s. net

Photograms of the Year, 1902. (Dawbarn & Ward.) 3s. net.

Rise of the Experimental Method in Oxford. By Prof. Clifford Allbutt, M.D., F.R.S. (Frowde.) 1s. net.

Variation and Correlation of the Human Skull. By Cicely D. Fawcett, B.SC., assisted by Alice Lee, D.SC. (From *Biometrika.*)

Proceedings of the Yorkshire Geological and Polytechnic Society. Edited by W. Lower Carter, M.A., F.G.S., and William Cash, F.G.S. (Leeds: Chorley & Pickersgill.)

Journal and Proceedings of the Royal Society of New South Wales. Vol. XXXV., 1901. (London: Robertson Proprietary.)

Encyclopædic Dictionary. (Cassell.) Part I. 6d. net.

Fiction of the Ice Age or Glacial Period. By Francis D. Longe. (Lowestoft: McGregor & Fraser.)

Report on the Work of the Department of Technology, City and Guilds of London Institute. (Murray.) 1s.

Publications of West Hendon House Observatory, Sunderland. By T. W. Backhouse, F.R.A.S. (Sunderland: Hills & Co.)

Chronographical Table for Tobacco. Dr. Prof. O. Comes. (R. Scuola Superiore d'Agricoltura, Portici, près Naples.)

The Riddle of the Universe. By Ernst Haeckel. (Watts.) 6d.

New Catechism. By M. M. Mangasarian. (Watts.) 6d.

Force of Mind. By A. T. Schofield, M.D., M.R.C.S. (Churchill.) 5s. net.

Photography. Xmas Number. (Iliffe.) 1s. net.

THE BACKBONE OF LEINSTER.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S.

THE Backbone of Leinster has been previously referred to* as a typical Irish representative of the great Caledonian folds, which run north-east and south-west across so many mountainous regions in our islands. It is the most continuous feature of eastern Ireland, and its rounded summits, clad with heather, and from 2000 to 3000 feet above the sea, rise from a moorland seventy miles in length.

As I write in my study on the little ridge of Tulla, *Tulach-na-nespuc*, the meeting-place of Irish and of Dane, I look across the rough hedgerows and the valley, to where the gorse flares on the first slopes of Carrickmines. The granite crops out in bare knobs among the bushes, and forms, with its smooth natural slabs, a paving for the paths across the hills. On the left rises the grey quartzite cone of Carrickgollogan, and from this point the ground falls to the wooded demesnes along the sea. On the borderland, a square grey tower stands suggestively, a castle of the English Pale, set between the cultivated lowland and the moor.

On the right of this broad landscape, the great domelike mountains rise, one beyond another, the first promise of the wilds of Leinster. We can see the bare granite again on the slopes above Glencullen; and after that it is almost all granite, away south-west through Carlow, and down to the heart of Waterford. The highest point visible in the distance is Douce Mountain—pronounced Djowse—2384 feet above the sea. Long after the foothills have become green in springtide, Douce may gleam white in the morning sunlight, and tell us that fresh snow has fallen all along the range.

* "The Structure of Ireland," KNOWLEDGE, Vol. XXI. (1898), p. 76.

It is hard to believe that the streets of Dublin lie only seven miles away in the great limestone plain; and Dublin has always known and felt the nearness of the Leinster moors. Even to this day, the coast and port, and the lower valley of the Liffey, are largely held and worked by men of English names; the highland that calls us out from Dublin at the end of each southward-stretching avenue is still, to all intents, the land of the O'Tooles and the O'Byrnes.

The mouth of the Liffey, and the deltas of old glacial gravel along the shore, were an obvious temptation for the Norse invaders. After plundering the islands, the sea-kings grew bold and settled on the land; they found Dublin a group of green raths guarding a river-ford, and they made it a busy port and city. None but a sea-faring people need have used Dublin as their capital. The central Irish fell on it from time to time, and the Scandinavians sought safety in alliance with the hill-men. Even Brian, after a month of plundering, left the city to be reoccupied by the enemy; to be king in Ireland was to be lord of the great central plain. And thus it came about that the Normans, in 1170, took Dublin from their old Norse kinsfolk rather than from the Irish.* From first to last, Dublin was a stronghold of the stranger.

Strongbow's Normans, with his southern allies, actually surprised the city by coming down on it across the granite hills. Out of the same hills, and creeping through the woodland, on a fatal day forty years later, the O'Byrnes and O'Tooles in turn fell on the men of Dublin. Two hundred years passed, in which the English forces were again and again broken on the highland, and still a battle had to be fought at Bray, at the seaward end of the landscape we have just described, where the O'Byrnes were taught for a time to regard the limits of the Pale.

Within their highland, however, they were always safe enough. The great fight in the ravine of Glenmalure, where Lord Grey's army was shot down by hidden musketry, reads like an Elizabethan version of some mishap in the late Boer war. In 1591, again, young Hugh Roe O'Donnell fled from his prison in Dublin straight to the unconquered hills; and few will grudge him his successes of the next ten years. In the bitter and unreasoning days of 1798, six centuries after Strongbow captured Dublin, the Backbone of Leinster was still to be reckoned with, as the natural rival of the plain.

Strangely enough, and yet appropriately, the denuding forces of rain and rivers, and the storm-winds that swirl, from south-east or south-west, round the northern angle of Slieve Roe, are still bringing to light the features of an older Ireland. Eras ago, the region was covered by the muds of a Silurian sea, and graptolites possessed what now is solid land. Then came the great stresses of the Caledonian folding, and the beds were crumpled from south-east to north-west, in common with those of Wales, the Lake District, and Scotland. Judging by the features laid bare in the Scotch Highlands, and to some extent repeated in Donegal, this epoch of earth-movement produced veritable mountain-chains. The mass of upheaved sediment was at any rate sufficient to allow of the consolidation of granite beneath its arches as it came to rest; while the upward folding went on, the igneous magma followed, and occupied the hollows of the rising chain.†

* *See* Joyce, "A Short History of Ireland," 2nd ed., pp. 207 and 256.

† Compare Sollas, "Geology of Dublin and its Neighbourhood," *Proc. Geol. Assoc.*, Vol. XIII. (1895), p. 107.

This profound change in the geography of the British area occurred without obvious warning. It is true that volcanic eruptions had converted the Welsh Sea into an archipelago in Ordovician times, and cones were spouting out lava and scoriæ both north and south of the site of Dublin. But the Gotlandian (Upper Silurian) period had been far more peaceful. One little volcano exploded in the west of Kerry, where its tuffs and agglomerates are brilliantly seen at the present day; but the sea-floor showed no sign of upheaval till near the end of the period, and the ash-beds of Ordovician times were already safely buried in marine deposits. Then came the great waves of the earth's crust, rising in some places only to subside again, but in others perpetuated, where they struck on some resisting mass below. An old north-western Archæan continent probably provided the obstacle in our area; and Cambrian, Ordovician, and Gotlandian beds were thrust against it, and were pressed over one another as the waves continued to advance. Forced up by the same earth-pressures, molten matter flowed in from below, attacking the walls of its caldrons and oozing into every crevice. When this matter ultimately cooled, the long anticlinals remained supported by solid granite cores.

This was the state of things when the Devonian lakes began to gather in the hollows of the land. A certain settlement of the ground assuredly went on, since no new continent can become at once exactly balanced amid all the complexities of the crust. The volcanic eruptions which left such traces in the Scottish Old Red Sandstone, and of which we have hints in Kerry and Tyrone, probably mark the weak lines in the Devonian land. Besides the actual tuffs and lavas, a multitude of dykes, and new intrusions of granite, cut through the Caledonian folds, and show us the dangers to which the continent was exposed. The vast thickness of the Old Red Sandstone indicates, moreover, that the lake-floors were steadily sinking as deposition went on in them.

Thus it came about that the sea again asserted itself, and marine beaches and mud-flats spread across the Devonian layers. For a long time certain high masses stood out as promontories and islands, and the rivers continued to wear them down, and to add their *débris* to the conglomerates forming on the shore. Judging, however, from the occurrence of remarkably pure beds of marine limestone close against masses of Caledonian land, atmospheric denudation was not very active, and the corals and other organisms flourished undisturbed in littoral waters. At the north end of the Leinster Chain we have the most complete proofs, often referred to by geologists, that the denuding forces had already worked down to the granite core. In one or two quarries between Dublin and the hills, lumps of granite occur scattered in the limestone, together with flakes of altered Ordovician shale. Some difficulty has been raised as to how these materials came down in isolated patches from the mountains; but they may represent the last relics of submerged granite knobs, just as banks of subangular gravel represent the lost land off our modern Atlantic coast. The striking Inch conglomerate in the Old Red Sandstone beds of Kerry, the origin of which is quite unknown, is an extreme example of the same kind.

The fine black mud that darkens so many layers of the Dublin limestone, and even provides material for bricks, was doubtless also derived from the waste of Caledonian land. The Leinster Chain stood there, then as now, looking down upon the sea, with the quartzites and slates of Howth and Bray forming rugged islets a little to the east. The dead Ordovician volcano of Portrane and Lambay doubtless formed another island to the north, with quaint

Carboniferous trees gathering on its flanks. The scenery, but for the greater proportion of schist that still overlay the granite core, was essentially that of the present day. The sea-floor then sank, until the waters spread across the Irish midlands, and finally covered the stubborn heights of Donegal. By the opening of the Upper Carboniferous epoch, the Backbone of Leinster was probably entirely submerged.

The striking landscape of early Carboniferous days was thus buried in soft limestone-mud, in shell-banks and coral reefs, and seemed for ever lost to view. Coal-Measure forests stretched across the country, which, in place of mountain ridges, now exhibited a monotony of sandy and swampy flats. The Hercynian uplift, however, altered these conditions; new folds set in, accommodating themselves to the unseen Leinster Chain below; the arch of Coal-Measures and limestone was broken away piece-meal from the buried mass of mountains; and at last the granite itself again began to be revealed.

Denudation at first was slow enough, through the arid Triassic days; but, little by little, the ancient features were restored. Even the great glacial incident at the close of the Cainozoic era only moulded the general outlines, and left undulating mounds of gravel against the severer mountain-slopes. These glacial deposits, which have been largely re-arranged by rivers, are nowadays mostly cultivated, and can easily be picked out, as smooth green areas, under the heather-clad or rocky hills. They often fill the old notches and stream-cuts of pre-glacial days. When we speculate as to the age of this or that valley in the Leinster Chain, we are tempted to ask if any of them can belong to the remote and primary Caledonian drainage system. There must have been original transverse valleys, which became flooded and infilled by the deposits of the Carboniferous sea. Can any of these have survived, to be re-excavated by the streams of later days?

Let it suffice that modern denudation is paring away the Carboniferous Limestone from the antique surface of the hills. The glacial gravels show how vast a quantity of this limestone has been broken up in recent times. And the long-lost Caledonian highland, perhaps reduced to half its former height, emerges along the present lines of foothills, and forms the central granite moors.

When Mr. Weaver,* in 1818, first gave a detailed account of the structure of the Leinster Chain, he traced the junction of the granite and the schists from Killiney southward. He noted the interlamination of granite and mica-slate in Glenmalure, and the cap of the latter rock left behind three thousand feet up on Lugnaquillia. Weaver says that the passes across the range were in his day scarcely practicable, even in summer; and Glenmalure, which is now abandoned, seems then to have been the best of them. The military road, made after 1798, to command the heads of the glens, gave Weaver access to the interior of the range.

In our time, there remain large central tracts which are scarcely ever traversed. They lie remote from any cart-track, and are difficult to visit in a day. But the chief beauty of the mountains lies in the contrasts between the granite and the stratified foothills. The streams that form broad basins on the central moorland give rise to cañons in the jointed rocks of the lower ground. The grey quartzite of the Bray series forms a series of striking summits between the sea and the main watershed; while the splintery Silurian shales, converted along the junction into gleaming mica-schists, weather into rocky slopes, on which the lines of stratification are apparent. Where the granite has eaten into them, as at Luggela, near Roundwood, or on the crest of Douce, or down against the sea in the typical section of Killiney, andalusite and garnet have developed; and a banded structure is often found in the adjacent granite. This was noted by Weaver,* who speaks of it as an approach to gneiss; and Sollas† regards it as due in some places to original flow, and in others to pressure acting on the solid mass, in continuation of the forces that upheaved the Caledonian chain. The granite has been stated to be but little modified by absorption of matter from the walls of its caldron; but it often becomes richer in dark mica near its margins, and assumes here and there the aspect of a composite gneiss. On the whole, however, as Haughton long ago pointed out, it preserves a remarkable uniformity throughout the length of the great mass.

To those who would appreciate the structure of the chain, and the contrasts of scenery on its flanks, the famous Military Road offers a ready introduction. There are some five miles of climbing on it out of Dublin, until we reach the watershed, where we are far up on the old Slieve Roe, a region of heather and high-lying peat, with the crag above Lough Bray prominent before us in the south. Most of the rock-exposures and romantic river-clefts lie in the older Palæozoic foothills; the granite furnishes a gathering-ground for the streams, and its long slopes are only here and there broken by a cirque or some unburied talus. The lower Lough Bray lies in a semicircular hollow, which was once occupied by a residual glacier, and so remained protected while other craggy features disappeared. It is divided from the upper lake by a huge glacial dam, from which we look into a second cirque, carved out originally when the denuding forces were more severe. Already the grass is climbing across the old rock-walls, and the deltas of sand, formed of fragments of felspar and quartz and mica, are spreading out into the lakes. Lough Tay, farther south, has similarly been invaded by the green delta of Luggela; and the fine crag above it belongs to the older order of mountain-landscapes. Only the young granite ranges, like the Mont Blanc *massif*, the Pelvoux, or, in their own small way, the Mournes, retain their array of peaks and pinnacles. Even among the Mournes, or the equally Cainozoic Red Hills of Skye, the decay and rounding-off of the older features are already obvious. The characteristic smooth dome is already prevalent in these wind-swept granite uplands.

If we climb again from the last cottage at Lough Bray, we find, in a waste moorland, the infant Liffey rising as a mountain-stream. It pours down a fine and wooded valley to the east, and then cuts deeply into the Silurian shales. At Pollaphuca, "Puck's Pool," the cascade and chasm are the last highland feature; the river then goes off wandering into the limestone lowlands of Kildare, bends northward at Kilcullen, and finally cuts through the recent and glacial gravels on its way to the sea at Dublin. Mud-brown and commercial though it may be within the city, two miles out it speaks of the unbroken country. At Leixlip (the "salmon-leap"), the name reminds us of the Norsemen, the strong sea-power that founded Dublin; but the water, pouring across the rocky ledges, is still fresh from that larger Ireland which waits for us on the Leinster hills.

* "Memoir on the Geological Relations of the East of Ireland," *Trans. Geol. Soc.*, Ser. I., Vol. V. (1821), p. 117.

* *Op. cit.*, p. 132.

† "Contributions to a knowledge of the Granites of Leinster," *Trans. R. Irish Acad.*, Vol. XXIX. (1891), pp. 492 and 496-502; also "Geology of Dublin," *Proc. Geol. Assoc.*, Vol. XIII. (1895) pp. 108-111.

Conducted by M. I. Cross.

PROGRAMME FOR 1903.—It is intended in future to devote a larger amount of space to Microscopy than hitherto, and by the co-operation of specialists to publish articles treating on different departments of both the popular and scientific sides. Among those who have promised to contribute are the following:—Mr. Rousselet, "How to Collect Rotifers," and "How to examine Pond Life under the Microscope"; Mr. C. D. Soar, "The Collection, Examination and Preservation of Water Mites"; Mr. Earland, "Coccoliths and Coccospheres"; Mr. Wesché, "The Mouth Parts of the Tsetse Fly in comparison with those of the Gnat, Gad Fly, etc.," and notes on entomological subjects; Mr. F. Noad Clark, "The Photography of Opaque Objects"; Mr. Sanger Shepherd, "Photo-Micrography in Natural Colours"; and other similar articles will appear.

It is hoped that these new arrangements will greatly increase the value of the microscopical notes, and maintain the interest which has so far been evinced.

As occasion offers, specimens will be offered for distribution as in the past year, and the assistance of readers who may be able to spare interesting material for the purpose will greatly increase the usefulness of this section. It is hoped that some Spongilla, spicules of sponge, etc., will be available for the January number.

POND-LIFE COLLECTING IN DECEMBER.—Severe weather in this country does not, as a rule, set in in December, and the lakes and ponds are not usually frozen over in the early part of the month. The winter fauna has now become more pronounced, but includes quite a number of Infusorians, Rotifers and Crustaceans. The following species of Rotifers have been collected in December in lakes and canals in and round London, some of them in great abundance: *Anuræa aculeata* and *cochlearis*, *Asplanchna brightwelli* and *priodonta*, *Brachionus angularis*, *Diaschiza semiaperta*, *Euchlanis deflexa*, *Melicerta ringens*, *Oecistes crystallinus*, *Limnias ceratophylli*, *Floscularia cornuta*, *Synchæta pectinata* and *tremula*, *Conochilus unicornis*, *Rotifer vulgaris* and *macrurus*, *Polyarthra platyptera*, *Notholca scapha*, *Triarthra longiseta*. Of Crustaceans, *Diaptomus castor* and various *Cyclops* and their larvæ are abundant, whilst Waterfleas die down. A minute red flagellate Infusorian often seems to form the chief food-material of the above lake fauna.

A few of the principal collecting grounds for Pond-life in and near London may be mentioned. The nearest and most convenient available piece of water is the Grand Junction and Regent's Canal, which runs from east to west, on the northern side of London, from Victoria Park to Hanwell, and is readily approachable wherever access can be gained to the towing path. Then all the great parks have a lake, such as Victoria Park, Regent's Park, Hyde Park, Richmond Park, Wimbledon Common, etc., which all afford good collecting grounds. Smaller ponds are found in abundance in fields and commons in and beyond suburban London, and I need only mention a few such places: Epping Forest, Higham Park, Hauley Wood, Totteridge, Hampstead Heath, Ealing Common, Hampton Court, Putney Common.

MICROSCOPE CONSTRUCTION.—The fact that the majority of the British makers of microscopes have to a greater or less extent conformed to an orthodox pattern of microscope stand, would lead one to imagine that for the time being, at any rate, finality had been arrived at, and that the best possible in microscope stands was at the disposal of microscopists. The Continental people, with very slight exceptions, also adhere to a model which is wonderfully uniform, so far as its advantages are concerned, in the different makes.

The "Nelson" model microscope, supplied by C. Baker, was practically the prototype of all the later tripod foot instruments, but is the tripod foot as at present made the best possible for convenient working? What is the real advantage of having straight legs to the front instead of those which may be slightly curved, so that access to the substage and its apparatus (especially in microscopes of small size) may be as conveniently attained as in those microscopes which are built on a horseshoe base?

Microscopists are at last realizing the advantages derivable from a tripod foot, but it is very desirable that disadvantages associated with this pattern should be removed. There is still room for a fine adjustment which shall be carried by the rack-work instead of itself carrying the rack-work portion of the instrument. Swift's "Climax," which he still fits to his "Challenge" and "Paragon" stands, is one of the best devices of this kind, but the laboratory worker wants a fine adjustment milled head in the usually accepted place at the back of the limb.

The mechanical stage certainly needs a greater range of movement, and the milled heads should be below the level of its upper surface. The Continental makers get over this difficulty by supplying controlling heads of very small diameter, which of necessity cannot impart that fine movement which is to be found in the British microscopes. Mr. Nelson many years ago devised a mechanical stage having vertical rack-work movement only, and in order to bring the controlling milled head below the level of its surface, fitted the rack itself beneath the main plate of the stage.

The difficulty that always arises in giving a long movement to a stage is that of the upper lens of the condenser fouling the plates, but this can be obviated, especially with the smaller mounts carrying the achromatic condensers which are so largely coming into vogue.

Then a greater range is required in the body length. I have had specimens sent to me for examination by readers which have been covered with a glass which could only justly be described as attenuated window pane. The wonder is that any self-respecting microscopist could ever spoil his objects by protecting them with such covers. Some I have been unable to examine with a high power at all, while others for critical examination have necessitated an exceedingly short tube-length, sometimes four inches only. This cannot be arranged on the average present day model of microscope.

Then—for amateur purposes especially—it is often felt that there should be a greater interval between the upper surface of the stage and the lower part of the limb of the microscope. The modern microscope is built very closely, and the earlier type, such as the Swift "Challenge" mentioned above, is altogether superior in the comfort it affords in this respect.

A handle by which to lift the microscope has been provided in Zeiss' new photographic stand; this is a convenience which would be much appreciated in other microscopes.

Such matters as these which have been referred to can be more easily incorporated in a microscope of large size than in the popular medium-sized models, but it is to be hoped that the inventive faculty may not become dormant in microscopical matters—there is room for improvement yet.

It is impossible to deny the tribute that is due to Messrs. Powell & Lealand for the prevision which caused them to incorporate many of these features in their large model stand. My own feeling has never been in favour of a coarse adjustment on a bar fitting; it certainly does not meet the needs of every class of worker in a way that the more recently designed stands have done. Could not the better points of the Powell stand be incorporated in other instruments by the exercise of ingenuity?

MICRO. PROJECTION.—A very large number of those people who possess microscopes also have a magic lantern, and a considerable amount of pleasure can be imparted by the projection of micro. specimens upon the screen. Several neat attachments are made to screw into the magic lantern in place of the ordinary lens, and, with suitable condensers and the use of the ordinary micro. objectives, fair results can be secured. It is essential that limelight be used as the illuminant, or, preferably, an arc lamp; anything less than either of these produces dismal results.

Nothing is more popular than the projection of pond life upon a screen; as this is a subject which, in the exhibiting of the commoner and larger forms, does not call for the use of high magnifications, it can be done with facility. Specimens to be exhibited should be placed in a trough having a small interval between the base and the cover, so as to keep the objects so far as possible, in one plane. Also the area for free swimming should be a restricted one. Rotifers and some of the smaller subjects could be well shown by placing them in an excavated slip and covering them with a thin cover-glass; compressors and live-cages also have their uses.

But apart from this one subject there is a large range of general objects which would always prove of interest, and the suggestion of selfishness which is frequently attributed to the microscopist, working by himself, would be removed, and an opportunity afforded of giving interesting pleasure to many others.

NOTES AND QUERIES.

C. Upton.—I would dehydrate the lichen in absolute alcohol. Clear in clove oil, then wash away all trace of oil with repeated changes of benzole or naphtha; infiltrate and embed in paraffin wax; cut sections, wash away paraffin with benzole or turpentine and mount in Canada balsam.

Seco.—The photographs you send are very nice and sharp. No. 1 seems to be correctly exposed, but No. 2 appears to be a little over exposed: the detail, however, is nicely shown. The method of ascertaining the magnification when photographing is to project the line of a stage micrometer on the ground-glass screen, and then by measuring the intervals between the magnified lines the magnification can be at once known.

C. Poulter.—Both the specimens you send are *Sertularia operculata.*

G. H. Johnson.—Your query is replied to by the notes which appear in these columns.

H. Taylor.—It is a little difficult to reply to your question without knowing how your objects are mounted. As you incidentally mention pond life, it is to be assumed that you are trying to get a dark ground illumination with objects in troughs. I would suggest that, first of all, you tried to get a black background with an ordinary transparent mounted object such as spicules of sponge or diatoms. With an Abbe Illuminator you will find it necessary to let the front of the top lens practically touch the object glass, and it is essential that the black patch stop that is used shall be of suitable size. Also do you shade the light of the lamp from the upper side of the stage of the microscope? With these precautions there should be no difficulty in obtaining a good black background with the arrangements you make when using the 1-inch or $\frac{1}{2}$-inch, but you must not expect a black background with a $\frac{1}{6}$-inch objective. You might get an inferior one by using the Iris Diaphragm at the back of the objective, but it is really not worth the trouble.

O. Heath.—I know of no work that gives the anatomy of the whole order of Insecta; there are special books such as Huxley's "Invertebrata" which gives an account of the cockroach (*Blatta orientalis*), commonly known as the "black beetle," Lowne's "Anatomy and Physiology of the Blow-fly," and Miall's "Harlequin Fly." Packard's "Entomology for Beginners" is an excellent *multum in parvo.* Have you a copy of Kirby and Spence's book on insects? This is at once one of the most informing and interesting books you can read.

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.

PERRINE'S COMET (1902B).—This comet passed through its perihelion on the morning of November 24th, and has travelled too far to the south to continue visible to northern observers. It was at its least distance from the earth on October 8th, and, theoretically, should have been at its greatest brightness on that date, but comets usually exhibit an increase in light as they approach the sun and the present one appeared fully as conspicuous during the third week of October as it did at any previous date. After traversing the constellations Scorpio, Centaurus and Argo Navis, the comet will return northwards, and, entering Canis Major, will be visible at about the middle of February in a position five degrees S.E. of Sirius, when it will be a little brighter than at the time of its discovery on September 1st. Observations of this comet will be exceedingly numerous and extend over a lengthy period. Many photographs of its aspect when nearest to the earth in the early part of October will also be available for discussion, in fact there will be an abundance of materials both for the computation of the definitive orbit and for the investigation of the physical appearance and changes of the object. There is every reason to suppose that the comet is moving either in a parabola or in an ellipse of great excentricity.

RECENT OBSERVATIONS OF METEORS.—Meteoric observers usually have a busy time in July and August, but in 1902 the weather conditions at many places prevented anything approaching a thorough re-observation of the Perseids or of the multitude of minor showers usually displayed at this productive epoch. Some fine meteors were seen, while the Perseid system appears to have exhibited normal strength and to have given the usual evidence of the easterly motion of its radiant. The following are a few of the positions determined between July 27 and August 12:—

Date.		Radiant. α °	δ °	Number of Meteors.	Observer.
July 27—28	...	28	+ 53	4	A. King, Leicester.
Aug. 1—3	...	37	+ 55	26	G. M. Knight, London.
Aug. 4—5	...	40	+ 55½	12	" "
Aug. 10	...	44	+ 58	9	A. King, Leicester.
"	...	44½	+ 57	43	G. M. Knight, London.
"	...	45	+ 58½	15	W. F. D., Bristol.
Aug. 12	...	47	+ 58½	9	" "
"	...	48	+ 56½	6	A. King, Leicester.

At Bristol observations were pursued between July 6–16, August 2—14, and August 25—September 7, and 260 meteors were seen. The most active and sharply defined radiants were as under:—

1902.		Radiant. α °	δ °	Number of Meteors.	Notes.
July 6—9	...	299	+ 24	6	Slow.
July 6—13	...	333	+ 57	6	Slow.
Aug. 24—Sept. 7	...	74	+ 41	7	Rapid, streaks.
Aug. 26—Sept. 7	..	337	+ 81¼	10	Rapid.
Sept. 3—7	...	118	+ 83½	9	Rapid.
Sept. 3—7	...	30	+ 37	8	Rapid.

FIREBALLS.—On October 15, at 7h. 47m., a fine meteor equal in brilliancy to Venus was seen by Mr. A. King at Newark, Notts. Its aspect was starlike, colour pale green, and duration 2¾ or 3 seconds. It moved slowly along a path of 27 degrees, from 280°—8° to 301°—26½°. The same meteor was observed by Mr. W. Lascelles-Scott at Little Ilford, Essex, who gives the time as 7h. 52m., and says that the object commenced its flight at a point rather higher than midway between the horizon and zenith in N.W. by N. It traversed a path of 105 degrees ending in S.W., and making an angle with the horizontal plane of 30 degrees. The meteor was also seen by Mr. C. B. Holmes, of St. Albans, who describes the path as nearly parallel with the bright stars Vega and Altair, and about 20 degrees to the west. Combining the three observations, the approximate position of the radiant is indicated at 150° + 43°, and the height of the meteor from 62 to 54 miles. It had a long path of about 130 miles, extending from over Usk, Monmouth, to the English Channel, and the velocity was 37 miles per second.

On October 20, 8h. 13m., a meteor about as bright as Jupiter was observed by the Rev. W. F. A. Ellison, of Dublin, with a path from 15° + 46° to 42° + 28°, which it traversed in 1½ seconds.

THE FACE OF THE SKY FOR DECEMBER.

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

THE SUN.—On the 1st the sun rises at 7.44 and sets at 3.53; on the 31st he rises at 8.8 and sets at 3.57. Winter commences at 7 P.M. on the 22nd, when the sun enters the sign of Capricornus.

Sunspots may now be expected, small groups of spots having appeared from time to time of late.

The Moon:—

		Phases.	h. m.
Dec. 8	☽	First Quarter	6 27 A.M.
„ 15	○	Full Moon	3 47 A.M.
„ 21	☾	Last Quarter	8 0 P.M.
„ 29	●	New Moon	9 25 P.M.

The moon is in apogee on the 2nd and 29th, and in perigee on the 15th.

Several bright stars suffer occultation during the month; of these the occultation of ζ^1 Piscium on the 10th occurs at a convenient time, the times of the others are somewhat inconvenient.

Date.	Star Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
			h. m.	°	°	h. m.	°	°	d. h.
Dec. 4	β Capricorni	3·4	7 38 P.M.	38	4	8 33 P.M.*	286	248	4 18
„ 10	ζ^1 Piscium	4·2	7 8 P.M.	74	84	8 22 P.M.	238	232	10 18
„ 14	δ^1 Tauri	4·0	1 53 A.M.	86	51	2 56 A.M.	268	228	14 0
„ 14	δ^2 Tauri	4·7	2 27 A.M.	110	71	3 23 A.M.	245	205	14 1
„ 15	129 Tauri	5·3	4 52 A.M.	13	332	5 0 A.M.	355	315	15 3
„ 16	λ Geminorum	3·6	5 49 P.M.*	64	98	6 32 P.M.	302	310	16 16

* Star below horizon.

The Planets.—Mercury is unobservable, being in superior conjunction with the sun on the 12th.

Venus is an evening star, but sets too soon after the sun to be observed.

Mars rises about midnight. His path is in Virgo, and at the middle of the month he is near β Virginis. He is in quadrature with the sun on the 24th, when the gibbosity is a maximum, 0·90 of his disc being illuminated. The angular diameter of the planet is about 6″·5.

Jupiter is observable throughout the month in the early part of the evening. At the beginning of the month he is on the meridian at sunset, and sets about 8.45 P.M. Near the end of the month he sets at 7.30 P.M. His brilliance is now waning and his diameter diminishing, the polar and equatorial diameters being 33″·6 and 36″·0 respectively on the 14th.

The positions of the satellites as seen in an inverting telescope at 5.30 P.M. are as follows:—

Day.		Day.	
1	4 1 ○ 3 2	17	3 4 2 1 ○
2	4 3 2 ○ 1	18	4 3 ○ 1 2
3	4 3 1 2 ○	19	4 1 3 ○ 2
4	4 3 ○ 1 2	20	4 2 ○ 1 3
5	4 1 ⊙ 3	21	4 1 ○ 3 ●
6	4 2 ○ 1 3	22	4 ⊙ $\genfrac{}{}{0pt}{}{3}{2}$
7	4 ○ 2 3 ●	23	4 3 2 ○ 1
8	1 ○ 3 2 ●	24	3 2 1 4 ○
9	3 2 ○ 1 4	25	3 ○ 1 $\genfrac{}{}{0pt}{}{4}{2}$
10	3 $\genfrac{}{}{0pt}{}{2}{1}$ ○ 4	26	1 3 ○ 2 4
11	3 ○ 1 2 4	27	2 ○ 1 3 4
12	1 ○ $\genfrac{}{}{0pt}{}{3}{2}$ 4	28	1 2 ○ 3 4
13	2 ○ 1 3 4	29	○ 1 $\genfrac{}{}{0pt}{}{3}{2}$ 4
14	1 ○ 3 4 ●	30	3 ⊙ 4 ●
15	1 ○ 3 $\genfrac{}{}{0pt}{}{2}{4}$	31	3 2 1 ○ 4
16	3 2 ⊙ 1		

The circle (○) represents Jupiter; ⊙ signifies that the satellite is on the disc; ● signifies that the satellite is behind the disc, or in the shadow. The numbers are the numbers of the satellites.

Saturn sets too soon after the sun to be observed.

Uranus is in conjunction with the sun on the 14th, and is therefore unobservable.

Neptune is observable throughout the night. About the middle of the month he rises at 4.30 P.M., and is on the meridian at midnight, being in opposition to the sun on the 14th. On the 1st of the month he is to be found midway between η and μ Geminorum, and 17′ south of the line joining the two stars, whilst on the 31st he is exactly 14′ south of the star η Geminorum.

The Stars.—The positions of the principal constellations near the middle of the month at 9 P.M. are as follows:—

Zenith . Perseus, Cassiopeia.

South . Andromeda, Aries, Pleiades, Cetus; to the S.W., Pisces; to the S.E., Taurus, Orion, *Sirius* rising.

West . Delphinus, Cygnus, Pegasus; Lyra to the N.W.

East . Auriga high up, Canis Minor (*Procyon*); Leo rising in the N.E.

North . Ursa Major, Ursa Minor, Cepheus, Draco.

Minima of Algol occur on the 1st at 5.15 P.M., 16th at 1.20 A.M., 18th at 10.9 P.M., 21st at 6.58 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. 19.

Key-move.—1. B to B8.

As there is a dual in the composer's main variation, duals alone need be mentioned here. After 1. . . . B to Ksq there is a dual by 2. Q to R5, or 2. P to K5ch; after 1. . . . B to Q2, by 2. P to K8 (Q), or 2. P to K5ch; and after 1. . . . B × Kt P, a quadruple by 2. P to K5ch, or promotion of the Pawn to Q, R, or Kt.

No. 20.

Key-move.—1. Q to B5.

If 1. . . . P × Kt, 2. P × P, etc.
1. . . . P to K3, 2. Kt to B3, etc.

After 1. . . . P × P, there is a dual by 2. Q to Kt5, or 2. B to B4.

No. 21.

The author's solution is 1. . . . R to QB7; but there are two others commencing with 1. . . . Kt to QKt7, and 1. . . . Kt to K4.

Solutions received from W. Nash, 4, 4, 6; W. Jay, 6, 5, 6; G. Woodcock, 4, 4, 4; C. Johnston, 6, 4, 6; "Looker-on," 6, 5, 6; J. W. Dawson, 5, 4, 4; Lt.-Colonel Damania, 4, 4, 4; Eugene Henry, 0, 4, 4; J. S. Davis, 0, 0, 0; W. H. Jones, 4, 0, 4; "Alpha," 4, 0, 4; "Tamen," 5, 4, 4; G. A. Forde (Capt.), 4, 0, 4.

J. W. Dawson.—You are quite correct. I regret the mistake in simple addition.

Lt.-Col. Damania.—A dual is a choice of two equally effective continuations on White's *second* move, a triple of three, etc.

W. H. Jones.—Probably you will find that Q to R6, in No. 20, is defeated by 1. . . . P × Kt.

Eugene Henry.—After 1. . . . Q to R2, in No. 19, Black is not compelled to capture the Queen.

J. S. Davis.—Perhaps you could get some friend to show you why your solutions are incorrect.

"*Tamen.*"—I do not understand what you mean by "a problem in lettered notation, of E. R., or the writing from E. R." Perhaps you could explain more clearly.

Mr. J. W. Dawson's score in the Solution Tourney should have been 74, instead of 72, as stated last month.

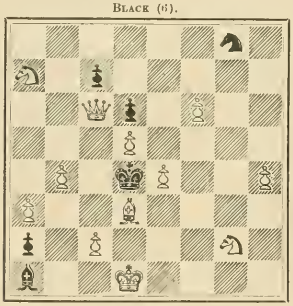
Mr. H. F. Griffiths, 17, Alwyne Road, Canonbury, N., would like to hear of an opponent for correspondence play. Mr. Griffiths describes himself as a medium player.

PROBLEMS.

No. 22.

"By indirection seek direction out."

BLACK (6).



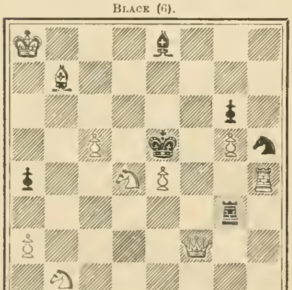
WHITE (12).

White mates in three moves.

No. 23.

"Seeing the thing through."

BLACK (6).



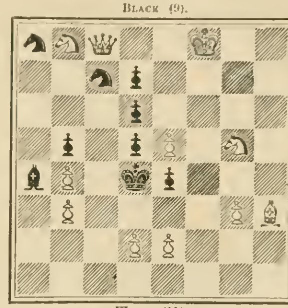
WHITE (10).

White mates in three moves.

No. 24.

"Weighty."

BLACK (9).



WHITE (11).

White mates in three moves.

CHESS INTELLIGENCE.

The Third Monte Carlo International Tournament will take place early next year. It will probably be a two-round competition, the players already invited being Lasker, Marco, Maroczy, Mieses, Pillsbury, Schlechter, Tarrasch, Tchigorin, and presumably Janowski. Dr. Lasker is now engaged on a chess tour in the United States. Mr. Pillsbury is at present in London, and has recently made some important contributions to the theory of the openings. By some very ingenious analysis he has once more demonstrated the soundness of the "Falkbeer Counter Gambit," for some time apparently demolished by Charousek. On the other hand, he has discovered a simple way of dealing with the "Gledhill" attack in the French Defence, by means of which Black gets out of his difficulties at an early stage and retains his numerical superiority.

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